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H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive summary

The ICES' Working Group on Mixed Fisheries Advice for the North Sea [WGMIX-FISH] (Chair: Steven Holmes (UK)) met at ICES HQ, 31 August-3 September 2010 to apply mixed fisheries forecasts to the North Sea single species advice released by ACOM in June 2010. The output from this group is the first operational application of the methodology and advice template developed by the ICES' Workshop on Mixed Fisheries Advice for the North Sea [WKMIXFISH] and Ad hoc Group on Mixed Fisheries Advice for the North Sea [AGMIXNS] which met in 2009.

The meeting has produced a North Sea Mixed Fisheries Advice (Annex 4) and associated North Sea Mixed Fisheries Annex (Annex 5) for use by the ACOM advice drafting group.

The species considered here as part of the demersal mixed fisheries of the North Sea are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. All of these are now subject to multi-annual management plans apart from whiting and *Nephrops*.

The mixed fisheries runs considered two advice approaches used by ICES, the F_{MSY} transition approach and the management plan (MP) approach. For each approach five scenarios were considered

- 1) **min**: The underlying assumption was that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary.
- 2) **max**: The underlying assumption was that fishing stops when all quota species are fully utilised with respect to the upper limit corresponding to single stock exploitation boundary.
- 3) **cod**: The underlying assumption was that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.
- 4) **sq_E**: The effort was set as equal to the effort in the most recently recorded year for which there are landings and discard data.
- 5) **Ef_Mgt**: The effort in métiers that used gear controlled by the EU effort management regime had effort adjusted according to the regulation.

The max and min scenarios were included to bracket the space of potential catch and SSB outcomes but for most fleets are considered unrealistic scenarios. Of the remaining scenarios none was picked as a preferred scenario.

As a cross check, the landings by national fleets were summed over nation for each scenario, and the share by country was compared with the initial proxy for relative stability used as input to the model. The results show that only minor deviations are observed across all scenarios, indicating that the approach used does not lead to violation of the underlying hypothesis of relative stability in the TAC sharing (quotas) across nations.

No methodological problems were encountered with the Fcube package, but issues were encountered with respect to data submissions and non-standard approaches in single species assessment forecasting. The data call this year mirrors that for the STECF effort meetings. A debate is needed intersessionally on whether a data call specification less similar to the STECF effort data call but considerably simplified would facilitate more timely and complete data submissions. It is also recommended that the next ICES WGCHAIRS meeting agree guidelines to achieve consistency in short term forecast methodology between stocks.

1 Introduction

1.1 Background

The **Working Group on Mixed Fisheries Advice for the North Sea** [WGMIXFISH] (Chair: Steven Holmes (UK)) met at ICES HQ, 31 August-3 September 2010 to apply mixed fisheries forecasts to the North Sea single species advice released by ACOM in June 2010. The output from this group is the first operational application of the methodology and advice template developed by the ICES' Workshop on Mixed Fisheries Advice for the North Sea [WKMIXFISH] (ICES 2009a) and Ad hoc Group on Mixed Fisheries Advice for the North Sea [AGMIXNS] (ICES 2009b) which met in 2009.

The current interest in fleet- and fishery-based approaches has its origins around 2002, when the conflicting states of the various demersal stocks in the North Sea made the limitations of the traditional, single-species approach to advice particularly apparent. The history of the adoption and development of the Fcube approach (after Fleet and Fishery Forecast) used by this WG is detailed in ICES (2009a)

The mixed fishery advice will be based on the CFP TAC regime and take relative stability into account. The circumstances of 2002 have also lead to the introduction of effort restrictions alongside TACs as a management measure within EU fisheries and there has been an increasing use of single-species multi-annual management plans, partly in relation to cod recovery, but also more generally. These developments are of key importance for the general approach to mixed-fisheries advice, which must build on the existing legal and management system. The species considered here as part of the demersal mixed fisheries of the North Sea are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. All of these are now subject to multi-annual management plans apart from whiting and *Nephrops*.

1.2 Effort limitations

For vessels registered in EU member states, effort restrictions in terms of days at sea were introduced in Annex XVII of Council Regulation 2341/2002 and amended by Council Regulation 671/2003 of 10 April 2003. The days at sea allowances have been revised by subsequent Council Regulations and the documents listing these days at sea limitations are given in Table 1.2.1

In 2008 the system was radically redesigned. For 2009 effort limits were changed to be on the basis of a kWdays effort pots assigned per nation per fleet effort category. The baselines assigned in 2009 were based on track record per fleet effort category averaged over 2004-2006 or 2005-2007 depending on national preference. Table 1.2.2 lists the new fleet effort categories and shows how they map to the previous gear groups. The latest effort allocations available by nation and gear are given in Appendix 1 of Annex IIa of Council Regulation (EU) 23/2010. Member states are permitted slightly larger allocations of effort in cases where that effort involves low cod catches, e.g. through the implementation of more selective gears or cod avoidance measures. Full details are given in Article 13 of Council Regulation (EC) 1342/2008 and a table summarising effort reductions imposed in the current year are included in the mixed fisheries advice annex. In relation to this, some member states have implemented real-time closure schemes. The closures apply to areas with high cod catch rates with the intention that closing these will lead to an overall reduction in the catchability of cod (Holmes *et al*, 2009).

In addition to the restrictions on effort, a number of other measures have been introduced since 2009 to help ensure that the cod quota is not exceeded. For instance, in 2010, if a nation's uptake of its cod quota reaches 90% on or before 15 October 2010, this will trigger a requirement for that nation's vessels to use highly selective gears (Regulation 23/2010, Appendix to Annex I, para. 1.5). This is associated with a ban on high-grading (Regulation 43/2009, Annex III, para. 5b).

1.3 Stock-based management plans

The species considered here as part of the demersal mixed fisheries of the North Sea were cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. All of these were subject to multi-annual management plans apart from whiting and *Nephrops*. These plans all consist of harvest rules to derive annual TACs depending on the state of the stock relative to biomass reference points and target fishing mortality. The harvest rules also impose constraints on the annual percentage change in TAC.

These plans have been discussed, evaluated and adopted on a stock-by-stock basis, involving different timing, procedures, stakeholders and scientists involved, and as such have never been evaluated in an integrated approach.

The full details and references of these plans are not always easy to find. The most important points of these plans are therefore reproduced in Annex 6.

1.4 Definitions

Two basic concepts are of primary importance when dealing with mixed-fisheries, the Fleet (or fleet segment), and the Métier. Their definition has evolved with time, but the most recent official definitions are those from the CEC's Data Collection Framework (DCF, Reg. (EC) No 949/2008), which we adopt here:

- *A Fleet segment* is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.
- *A Métier* is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area and which are characterized by a similar exploitation pattern.

2 Software

All analyses were conducted using the FLR framework (Kell *et al.* (2007); www.flr-project.org) running with R2.8.1 (R Development Core Team, 2008). All forecasts were projected using the same `fwd()` function in the Flash Package. The Fcube method is developed as a stand-alone script using FLR objects as inputs and outputs.

The Fcube model was presented and described in Ulrich *et al.* (2006; 2008; 2009). Brief details are presented below and a summary of the methodology is incorporated in the Mixed Fisheries Annex (Annex 5 to this report).

2.1 Fcube

The basis of the model is to estimate the potential future levels of effort by fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort was used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

The following five options (or scenarios) were explored:

- 1) **min**: The underlying assumption was that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary.
- 2) **max**: The underlying assumption was that fishing stops when all quota species are fully utilised with respect to the upper limit corresponding to single stock exploitation boundary.
- 3) **cod**: The underlying assumption was that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.
- 4) **sq_E**: The effort was set as equal to the effort in the most recently recorded year for which there are landings and discard data.
- 5) **Ef_Mgt**: The effort in métiers that used gear controlled by the EU effort management regime had effort adjusted according to the regulation.

Another option, the “val” option, was explored. This option adjusts fleet quota shares by weighting them according to the relative economic value of the species to the fleet. Fleets then fish out their largest ‘value quota share’. The option was not retained for advice purposes because results were similar to those from the sq_E option and in the interests of reducing the size of already information rich results tables it was felt only one of the options need be retained.

ICES advice was given in 2010 according to several approaches; precautionary approach, FMSY transition, management plans. Two advice approaches were considered by this WG, (see section 4) and the five scenarios listed above were applied to each approach. The EU effort management regime is described in Council Regulation (EC) No 1342/2008 and the latest effort limits are outlined in Annex II of Council Regulation (EU) No 23/2010.

3 Input data and recent trends

3.1 Stocks

3.1.1 Data

The assessment data for the different stocks were taken from ICES (2010). For, plaice, saithe, and sole, no modifications were needed to incorporate the assessment and forecast inputs into the mixed fisheries routine. It should be noted however that no saithe assessment was performed in 2010 due to various data missing, and thus the 2009 assessment was projected over three years instead. The same procedure was followed here. For whiting, the industrial bycatch component was included in the landings, whereas it is dealt with separately in the single-stock forecast. The same applied for haddock, for which the industrial bycatch is now extremely low. The single species haddock forecast also includes some non-standard procedures for projecting mean weight and mean selectivity, and this was accounted for as far as possible in the current mixed-fisheries forecast.

The cod assessment was performed with B-Adapt, which assumed “total removals” consisting of an “overall landings” estimate and a “discards estimates”. The use of the reported landings data from the different fleets was therefore not consistent with the assessment data used by B-Adapt. The Workshop therefore decided to raise the reported landings data from the different fleets to “overall landings” estimates, using the catch multiplier from B-Adapt. This multiplier was applied to all fleets.

Nephrops stocks were incorporated in the evaluation by functional unit. For the *Nephrops* stocks in FU 5, FU6, FU7, FU8, FU9, FU32, FU33 and *Nephrops* from areas outside the functional units, the ICES advice was taken for the Fmsy approach or the precautionary approach if no Fmsy figure was available. For the Management approach, the values calculated by STECF for the Policy paper COM(2010) 241 were used (see table 3.1.1.1), (STECF, 2010).

The functional units with separate stock indices from underwater surveys (FU6, FU7, FU8 and FU9) were treated as separate *Nephrops* identities in the projections whereas the four other functional units (FU 5, 10, 32 and 33) and catches outside of the functional units in the North Sea were omitted in the projections.

3.1.1 Trends and advice

Recent trends are described on a stock-by-stock basis in ICES (2010), and latest advice by stock is available on the ICES website. In order to give a global overview of all North Sea demersal stocks at once, this information is collected directly below. It should be noted that the ICES advice for 2011 is no longer a single advice but in most cases a threefold advice, depending on the objective. The first advice is based on reaching Fmsy in 2015 in 5 steps, namely the “Transition to an MSY approach”. The second advice is based on the precautionary reference points, called “Precautionary Approach”. The third advice is based on the management plan, if applicable.

3.1.1.1 Cod in IIIa – IV – VIId

SSB has increased since its historical low in 2006, but remains below Blim. Fishing mortality declined after 2000, and although its most recent trajectory is considered uncertain, it is estimated to be well above the long-term objectives of maximum yield,

and likely above Fpa. Recruitment since 2000 is poor, The assessment this year is considered more uncertain than the assessment conducted last year.

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to $((0.85 \cdot 0.8) + (0.19 \cdot 0.2)) = 0.72$ but because $SSB_{2011} < MSY_{Btrigger}$ fishing mortality should be further reduced accordingly to the ratio $(SSB_{2011}/MSY_{Btrigger})$ to 0.24. This results in landings including unallocated removals of less than 18 100 t in 2011. This is expected to lead to an SSB of 79 300 t in 2012.
- 2) Following the precautionary approach, even a zero catch in 2011 is not expected to result in SSB reaching Bpa in 2012.
- 3) Following the EU–Norway agreement management plan and the EU long-term management plan (Council Regulation (EC) 1342/2008). fishing mortality should be reduced to levels corresponding to 75% of F2008 in 2009 and 65% of F2008 in 2010. As long as the long-term phase of the management plans is not reached, in subsequent years further successive reductions of 10% have to be applied leading to a F in 2011 equal to 55% of F2008. This would lead to a TAC reduction of more than 20%. The management plans limits annual TAC variation to 20%. According to these rules, landings should be 32 240 tonnes in total for Subarea IV and Divisions IIIa West and VIIId in 2011.

3.1.1.2 Haddock in IIIa – IV

Fishing mortality has been below Fpa and SSB is above MSY Btrigger since 2001. Recruitment is characterized by occasional large year classes, the last of which was the strong 1999 year class. Apart from the 2005 and 2009 year classes which are about average, recent recruitment has been poor.

Advice

- 1) Following the ICES MSY framework implies fishing mortality to be increased to 0.3, resulting in human consumption landings of less than 36 000 t in 2011. This is expected to lead to an SSB of 218 000 t in 2012.
- 2) Following the precautionary approach, fishing mortality in 2011 should be no more than Fpa corresponding to human consumption landings of less than 74 000 t in 2011. This is expected to bring SSB above Bpa in 2012.
- 3) Following the EU–Norway agreement plan implies a TAC of 36 152 t in 2011 which is expected to lead to a TAC reduction of 5% and an effort increase of 29%.

3.1.1.3 Plaice in IV

The stock is well within precautionary boundaries. Recruitment has been around long-term average from 2005 onwards.

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to $((0.24 \cdot 0.8) + (0.20 \cdot 0.2)) = 0.23$, resulting in landings of 64 200 t in 2011. This is expected to lead to an SSB of 532 500 t in 2012.

- 2) Following the precautionary approach, fishing mortality in 2011 should be no more than F_{pa} (0.6) corresponding to landings of less than 144 400 t in 2011. This is expected to keep SSB above B_{pa} in 2012..
- 3) Following the EU management plan for North Sea plaice and sole (Council Regulation (EC) No. 676/2007) results in a TAC of 73 400 t and an effort increase of 12% in 2011. An initial evaluation of the plan by ICES could not reach a conclusion about whether the plan was precautionary. However, a catch of 73 400 t can be considered precautionary for 2011, given it is well below the catch according to the precautionary approach, resulting in a larger SSB and a smaller F compared to the precautionary approach option.

3.1.1.4 Sole in IV

SSB has fluctuated around the precautionary reference points for the last decade. Fishing mortality has shown a declining trend since 1995 and is estimated to be below F_{pa} in 2008 and 2009.

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to $((0.36 \cdot 0.8) + (0.22 \cdot 0.2)) = 0.33$ (higher than F_{MSY}), resulting in landings of less than 13 800 t in 2011. This is expected to lead to an SSB of 36 600 t in 2012.
- 2) Following the precautionary approach, fishing mortality in 2011 could be increased by up to 6% and SSB would likely be above B_{pa} in 2012. This corresponds to landings of less than 15 500 t in 2011.
- 3) Following the EU management plan for North Sea plaice and sole (Council Regulation (EC) No. 676/2007) implies a 10% reduction of F (TAC of 13 600 t in 2011, implying a 10% reduction in fishing effort), this is expected to lead to an SSB of 36 900 t in 2012. This leads to a TAC reduction of 4%, being within the 15% bounds of the management plan TAC change constraints.

3.1.1.5 Saithe in IIIa – IV – VI

An update assessment could not be run in 2010 due to missing and incomplete indices for 2009. The assessment of the 2009 working group meeting has been used as a basis for the forecast run that has been extended to 4 years. SSB is estimated to have been above B_{pa} from 2001–2008. From 2001–2008, F has been at or below the fishing mortality target of the management plan (0.3).

Advice

- 1) Following the ICES MSY approach implies fishing mortality to be marginally increased to 0.30, resulting in landings of 103 000 t in 2011. This is expected to lead to an SSB of 219 000 in 2012.
- 2) Following the precautionary approach, fishing mortality in 2011 would have to be increased by 27% to reduce SSB to B_{pa} in 2012. This corresponds to landings of less than 125 000 t in 2011.
- 3) Following the agreed EU–Norway management plan, 1) Maintain the SSB above 106 000 t, and 2) exploitation at $F = 0.3$ when the stock is above B_{pa} . In the current situation, the management results in landings of 103 000 tonnes in 2011. This is expected to lead to an SSB of 219 000 in 2012 and the change in TAC is within the 15% specified as maximum in the management plan.

3.1.1.6 Whiting in IV – VIId

SSB in 2009 is slightly higher than in 2008 but remains below average. Fishing mortality has been stable over the last 4 years. Recruitment has been very low between 2003 and 2007 with stronger recruitments estimated in 2008 and 2009, however the size of these recruitments are uncertain.

Advice

- 1) There are no reference points to enable MSY advice.
- 2) There are no reference points to enable precautionary advice. A 50 % reduction in F is needed to maintain SSB at the 2010 level. This corresponds to human consumption landings of less than 12 700 t in 2011 corresponding to 9 500 t from Subarea IV and 3 200 t from Division VIId.
- 3) There is currently no management plan for this stock.

3.1.1.7 *Nephrops* in Botney Gut (FU 5)

The state of this stock is unknown. Landings per unit effort (lpue) fluctuate without trend.

Advice

- 1) The state of the stock is unknown but lpue is fluctuating without trend indicating a stable stock status. Therefore, following the ICES MSY framework implies that landings in 2011 should be reduced from recent level. ICES cannot quantify the rate of reduction required.
- 2) In light of the fact that lpue is fluctuating without trend indicating a stable stock status, following the precautionary approach landings in 2011 should not exceed 980 t (the average of the past 3 years).
- 3) There is currently no management plan for this Functional Unit.

3.1.1.8 *Nephrops* in Farn Deep (FU 6)

The UWTv survey, fishery data and length frequency data all point to the stock continuing to be at a low level.

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies fishing mortality to be reduced to $(0.8 \cdot F_{2010} + 0.2 \cdot F_{MSY}) = 14.3\%$ with an additional reduction of 20% since SSB is below MSY Btrigger = 11.2 %, resulting in landings of 1600 t in 2011.
- 2) There is currently no advice given following the precautionary approach for this Functional Unit.
- 3) There is currently no management plan for this Functional Unit

3.1.1.9 *Nephrops* Fladen Ground (FU 7)

The perception of the state of the stock has not changed substantially since the assessment in 2009. The UWTv abundance is still at a high level relative to the historical time series although there has been a 25 % reduction in 2009 from the 2008 value. The stable mean sizes in the length compositions of catches (of individuals >35 mm CL) and recent estimated harvest ratios (removals/TV abundance) relative to per-recruit reference points suggest that the stock is being exploited sustainably.

Advice

- 1) 1) Following the ICES MSY framework implies the harvest ratio to be increased to 10.2 %, resulting in landings of less than 13 300 t in 2011.
- 2) 2) There is currently no advice given following the precautionary approach for this Functional Unit.
- 3) There is currently no management plan for this Functional Unit.

3.1.1.10 *Nephrops* in Firth of Forth (FU 8)

The perception of the state of the stock has not changed substantially since the assessment in 2009. The UWTV abundance has been at a relatively high level since 2003 and the 15 % reduction observed in 2009 is within the confidence bounds of the 2008 value. The TV survey information, taken together with information showing stable mean sizes, suggests that the stock does not show signs of overexploitation. The calculated harvest ratio in 2009 (dead removals/TV abundance) is above F_{max} .

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies the harvest ratio should be reduced to 21.7 % ($0.8 \times F_{2010} + 0.2 \times F_{msy}$), resulting in landings of 2000 t in 2011.
- 2) There is currently no advice given following the precautionary approach for this Functional Unit.
- 3) There is currently no management plan for this Functional Unit.

3.1.1.11 *Nephrops* in Moray Firth (FU 9)

The perception of the state of the stock has not changed substantially since the assessment in 2009. The TV survey suggests that the population is stable, but at a lower level than that evident from 2003–2005. There is no evidence from the mean size information to suggest overexploitation of the FU although the current low discard rate suggests that recruitment may be lower than it has been previously. There has also been an apparent increase in female catchability which when observed in other FUs has been associated with the stock having been overexploited.

Advice

- 1) Following the transition scheme towards the ICES MSY framework implies the harvest ratio to be increased to 13.7 % ($0.2 \times \text{harvest ratio}(F_{2010}) + 0.8 \times \text{harvest ratio}(F_{msy})$), resulting in landings of less than 1300 t in 2011.
- 2) There is currently no advice given following the precautionary approach for this Functional Unit.
- 3) There is currently no management plan for this Functional Unit.

3.1.1.12 *Nephrops* in Noup (FU 10)

The state of the stock is unknown.

Advice

- 1) There is currently no advice given following the ICES MSY framework for this Functional Unit.

- 2) There is currently no advice given following the precautionary approach for this Functional Unit.
- 3) There is currently no management plan for this Functional Unit.

3.1.1.13 *Nephrops* in Norwegian Deep (FU 32)

Landings per unit effort (lpue) have been relatively stable over the last 16 years and suggest that current levels of exploitation are sustainable. A slight increase in mean size in the catches in 2007 could indicate a reduced exploitation pressure.

Advice

- 1) The state of the stock is unknown but lpue is fluctuating without trend indicating a stable stock status. Following the ICES MSY framework landings in 2011 should be reduced from recent level. ICES cannot quantify the rate of reduction required.
- 2) In light of the fact that lpue is fluctuating without trend indicating a stable stock status, landings in 2011 should not exceed 640 t (the average of the past 3 years).
- 3) There is currently no management plan for this Functional Unit.

3.1.1.14 *Nephrops* off Horn's Reef (FU 33)

The state of this stock is unknown. Lpue has been increasing up to 2008, probably reflecting increase in gear efficiency (technological creep) in the last years. The mean sizes in 2005 catches and the increased lpue's in the subsequent years could indicate a high recruitment in 2005. The development in 2009 then suggests that the contribution of the 2005 recruitment to the stock now has faded.

Advice

- 1) The state of the stock is unknown but lpue and recruitment indications suggest no major changes in stock status. Following the ICES MSY framework landings in 2011 should be reduced from recent level. ICES cannot quantify the rate of reduction required.
- 2) In light of the fact that lpue and recruitment indications suggest no major changes in stock status, landings in 2011 should not exceed 1200 t (the average of the past 3 years).
- 3) There is currently no management plan for this Functional Unit.

3.1.1.15 *Nephrops* in Other rectangles (NEPOTH)

The stock status is unknown.

Advice

- 1) Following the ICES MSY framework landings in 2011 should be less than 1 900 t.
- 2) There is currently no advice given following the precautionary approach for this area.
- 3) There is currently no management plan for this area.

3.1.2 Software

The collation of WGNSSK data highlighted the great diversity of software and settings used in the single species assessments and forecasts, as illustrated in the text table below

Species	Assessment	Forecast
HADDOCK IV, IIIa and VIIb	FLR 2x, FLXSA	MFDP
COD IV, IIIa and VIIb	Stochastic B-ADAPT	Stochastic B-ADAPT
PLAICE IV	FLR 3.0, FLXSA	FLR3.0, FLSTF
WHITING IV and VIIId	FLR 2.x, FLXSA	MFDP
SAITHE IV, IIIa and VI	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE IV	FLR 2.x, FLXSA	FLR 2.x, FLSTF

In the mixed-fisheries runs, all forecasts run were done with the same FLR forecasts method (see chapter 2).

3.2 Fleets and métiers

3.2.1 Catch and effort Data

For this working group runs were performed using data submitted in response to a data call issued by ICES on 22 June 2010. The specification of the data call was based to a large extent on that used for the STECF SGMOS 10-04 for the evaluation of effort management, the main exceptions being vessel size categories specified to match fleet segments from the STECF AER (Annual Economic Report), catch and effort for *Nephrops* partitioned by *Nephrops* Functional Unit (FU), and the inclusion of economic value. The data call is included in Annex 2. Data was received from Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, the UK (E,W,NI) and UK(Scotland). Not all data could be provided by all nations. Data for 2009 was not available from France so that catch and effort for French fleets had to be assumed equal to 2008 values. Also discard data was incomplete for most countries. Points to note regarding data by nation are contained in Annex 3.

A complicating factor when incorporating *Nephrops* is the fact that the species is found in a number of distinct areas or functional units (FU), only some of which receive an abundance estimate (necessary to calculate a catchability). This WG followed the approach adopted by ICES (2009b) which is to perform the normal Fcube prediction for those FUs with absolute abundance estimates, then to calculate a ratio (R) of the yields to the ICES' advice for the same FUs. For those FUs without absolute abundance estimates, landings resulting from the Fcube run were simply taken to be the most recently recorded landings multiplied by the same ratio R. To do this, landings for each métier had to be apportioned across the FUs. This was facilitated by the supply of effort and catch data by FU.

3.2.2 Definitions of fleets and métiers

The starting point for defining fleets and métiers was to match definitions used in the cod long term management plan (Table 3.2.2.1). Fleets were further split by nation, and sometimes further by vessel length category. The decision to split by vessel length category was initially dependent of the availability of cost data from the Annual Economic Report (AER, cf ICES 2009a), and then to the overall importance of the fleet in terms of total effort. The latter consideration was to prevent unbalance in the relative size of fleets in the model.

In order to reduce the number of categories, an aggregation threshold, established through trial and error was used to determine 'small' métiers. A métier failing to catch 1.0% on average of at least one of the stocks considered was classified as small. All these small métiers are then aggregated by fleet in one "Other" métier (OTH). Further, all small fleets (i.e. containing only the "OTH" métier), were aggregated into one single "OTH" fleet.

The final data used contained 28 national fleets (plus the OTH fleet) from nine countries, from 2003 to 2009. These fleets engage in one to 5 different métiers each, resulting in 73 combinations of country*fleet*métier catching cod, haddock, whiting, saithe, plaice, sole and *Nephrops* (Table 3.2.2.1)

As a cross check of the data the total landings and discards across all fleets was compared to the values estimated from the single species stock assessments. The landings coverage for most stocks is high (over 80%), while it is only 50% for cod, due to the "unallocated removals" estimated by B-Adapt and raised to the landings and discards (Figure 3.2.2.1). To solve this inconsistency between fleets data and stock data the landings by fleets were raised to the unallocated catches. For the other stocks, the difference between fleet data and stock data were pooled into the "OTH" fleet (both landings and discards).

3.2.3 Trends

A number of overview graphs (using the Lattice package in R) were produced to aid quality checking of the data once compiled into the final fleets object. Some are useful to show the relative importance of the fleets chosen and trends in their effort and catches. Effort by fleet in absolute levels (Figure 3.2.3.1) and relative trends (Figure 3.2.3.2), effort share by métier and fleet (Figure 3.2.3.3) and landings by fleet and stock (Figure 3.2.3.4) are included in this report.

4 Mixed fisheries forecasts

4.1 Description of scenarios

4.1.1 Baseline Runs

The objectives of the single species stock baseline runs were to:

- 1) reproduce as closely as possible the single species advice produced by ACOM, and
- 2) act as the reference scenario for subsequent mixed fisheries analyses.

These runs used a forecast for each stock which used the same settings as the ICES forecast for the stock. For instance, the cod forecast used the same assumptions about the intermediate year (2010) as the WGNSSK forecast, i.e. that the TAC would not restrict catches. For stocks where ICES advice was made according to a long term management plan the rules of the plan were implemented in the baseline script. For *Nephrops* the recommendations for each functional unit (FU) made by ICES were replicated.

Rather than giving one specific advised catch for 2011 for each stock, The 2010 ICES advice for the North Sea demersal stocks includes catch options consistent with existing management plans, with the precautionary approach and with the transition to an MSY approach. Reflecting this development, baseline runs were run for both management plan and MSY advice approaches.

The intention of the baseline runs was mainly to act as a check to ensure that the projections were set-up correctly within the Fcube script, but these runs also have the incidental benefit of acting as a quality control check on the WGNSSK projections.

4.1.2 Mixed fisheries runs

4.1.2.1 Fcube analyses of the intermediate year (2010)

The single species stock forecast settings and target F for 2010 from the baseline run were used to perform some Fcube scenario analyses for 2010 (Run "OneYearFcube" – Single-Stock TargetF 2010). The aim of these analyses was to provide alternative sets of plausible levels of F by stock in 2010 accounting for mixed-fisheries interactions. This is similar to the base case run described and analysed in ICES (2008).

The Fcube scenarios **min**, **max**, **cod**, **sq_E** and **Ef_Mgt** were performed (see Section 2.1).

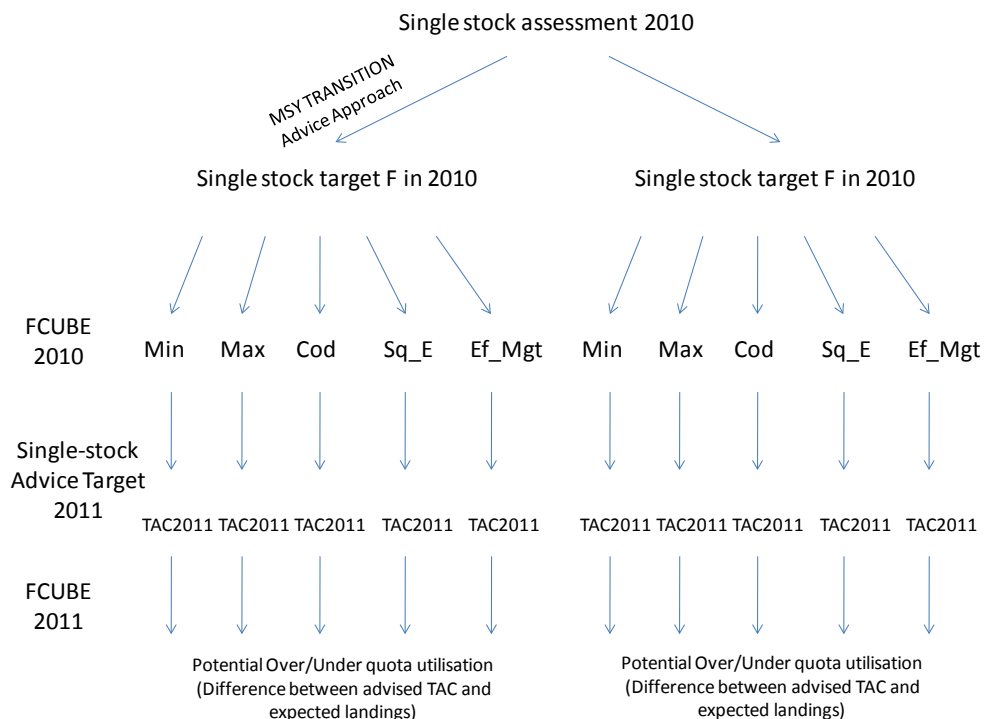
4.1.2.2 Fcube analyses for the TAC year (2011)

The new F2010 values by stock derived from the Fcube scenarios were used as input for the Intermediate Year in single-species forecasts, instead of the values from WGNSSK. The stocks were again projected to 2012, using the same settings (objectives and constraints) for 2011 as in the Baseline Run. The aim was to derive single species stock TAC advice for 2011 following the single species advice approach (Management Plan and MSY transition) but as if catch resulting from the assumed mixed-fisheries interactions in 2010 had come about and the data were available for the intermediate year. Finally, for each Fcube scenario, the same scenario was applied in 2011 to the stock results (numbers-at-age) resulting from applying that scenario for 2010. In this way both

- Differences in recommended TACs for 2011 resulting from the single species advice approach being applied to the stock status at the end of the intermediate year of different scenarios and
- An estimate of the cumulative difference between baseline run (single species advice) intermediate year catch plus TAC and realised catches over two years from each scenario,

could be calculated.

In summary, the Fcube runs followed the scheme below:



4.2 Results of Fcube runs

4.2.1 Baseline run

The rationale behind the single species baseline runs is given in Section 4.1.1. Tables 4.2.1.1a and 4.2.1.1.b. contain the outputs from these runs.

The issues and problems encountered in replicating the single species advice for each species are given below. The results from these baseline runs are compared with the results from the corresponding ICES runs in Tables 4.2.1.2 and 4.2.1.3.

Cod: The cod forecast is produced internally in the B-Adapt assessment method using the bootstrapped populations, and the median of the forecasted assessment may be slightly different from the forecast of the median assessment. This led to problems in precisely replicating the advice for cod. However, WGMIXNS group considered that while this was a source of slight concern, the inconsistency between the B-ADAPT and FLR derived catch estimates was too small to affect significantly the outcomes of the mixed fisheries work.

Haddock: Initial difficulties in replicating the haddock advice were attributed to the non-standard approach used to scale recent fishing mortalities in the WGNSSK forecast. The approach used to estimate weights at age for the forecast proved similarly resistant to automation, but using a four year mean provided a good approximation to the WG estimates.

Whiting: There are some minor discrepancies in the forecast catches from the WG and the FLR forecasts. These can be attributed to differences in the way the industrial by-catch is handled by the two approaches. In the WG forecast this is handled as a separate fleet with a fixed multiplier, whereas in the FLR forecasts it is included within the landings component.

In this case there were minor differences between the forecast results given in the WGNSSK report, and those summarised in the ICES advice. The reason for these discrepancies was not immediately apparent.

No management plan exists for whiting, but advice is based on maintaining SSB at its current level, i.e. the TAC for 2011 is set in order that SSB at the start of 2012 is the same as that in 2010. When this is implemented as a control rule in the FLR forecasts it can lead to some counter-intuitive results. In particular, the catches of whiting can exceed the TAC even under the 'MIN' scenario. This appears to be because the MIN scenario leads to a larger stock size at the start of the TAC year, hence a larger catch can be taken in order to meet the criterion of maintaining SSB at its target level.

Saithe: Straightforward, no problems encountered

Plaice: Straightforward, no problems encountered

Sole: Straightforward, no problems encountered

Nephrops: The forecasts applied the recommended harvest rates to the most recent abundance estimates available for the relevant FUs; hence the process replicated precisely the ICES advice.

4.2.2 Mixed fisheries analyses

4.2.2.1 Fcube analyses of the intermediate year

The Target F by stock for 2010 were set as the landings component of the F used in the Baseline (see table 4.2.1.1). That implied no reductions in F for any stock in the MSY Advice Approach, as status-quo was assumed for all stocks in the single-stock forecasts. In the MP Advice Approach, a 13% F reduction is applied to cod. It is to be noted that for cod and whiting, the single-species forecast assumptions used by ICES' WGNSSK (ICES 2010) (and reproduced here in the *baseline*) imply to some extent expected landings for 2010 higher than the actual TAC.

The Fcube scenarios **min**, **max**, **sq_E**, **cod** and **Ef_Mgt** were applied to these target Fs (Table 4.2.2.1.1 and Figures 4.2.2.1.1 to 4.2.2.1.8).

Last year, the most striking results were the discrepancies between the **cod** scenario and the other scenarios, due to the fact that the cod forecast in 2009 implied a 25% reduction in F in the intermediate year, which had consequences for all other stocks. This year, no such large discrepancies occurred, indicating a larger consistency across the individual single-stock forecasts and between these forecast and the effort level (**sq_E** scenario). Indeed, in the **sq_E** scenario under both MSY and MP advice approaches, overshooting of baseline catches are only observed for haddock, and to a minor extend. This is not surprising, since all single-stock forecasts assumed status

quo F in the intermediate year, except for cod in the MP advice approach, but this is considered to strengthen the reliability of single-stock forecasts in a mixed-fisheries context.

The **Ef_Mgt** scenario implies large effort reductions in 2010 in the main cod metiers (TR1, Tr2 and BT2), and this is expected to have a considerable impact on the catches of all other stocks beyond cod.

The **min** and **max** scenarios are still kept in the figures as illustrative boundaries, but it is the agreed understanding of the WGMIXFISH group that these scenarios are not realistic in a management perspective. Hindcasting exercises over historical data have been conducted (Ulrich et al., publication in prep.) showing that the actual realised effort had been in almost all cases in between but far from the min and max estimates, and closer to the **sq_E** and **val** scenarios. This can be understood when looking at the effort estimates for the various fleets corresponding to their various quota share (Figures 4.2.2.1.1 and 4.2.2.1.5) estimated through the relationships between F, effort and catches, where it is clear that for most fleets the **max** estimate is driven up by non-important by-catch species, such as haddock for the Belgian beam trawl fleet (BE_beam) or sole for the Scottish static fleet (SC_Static).

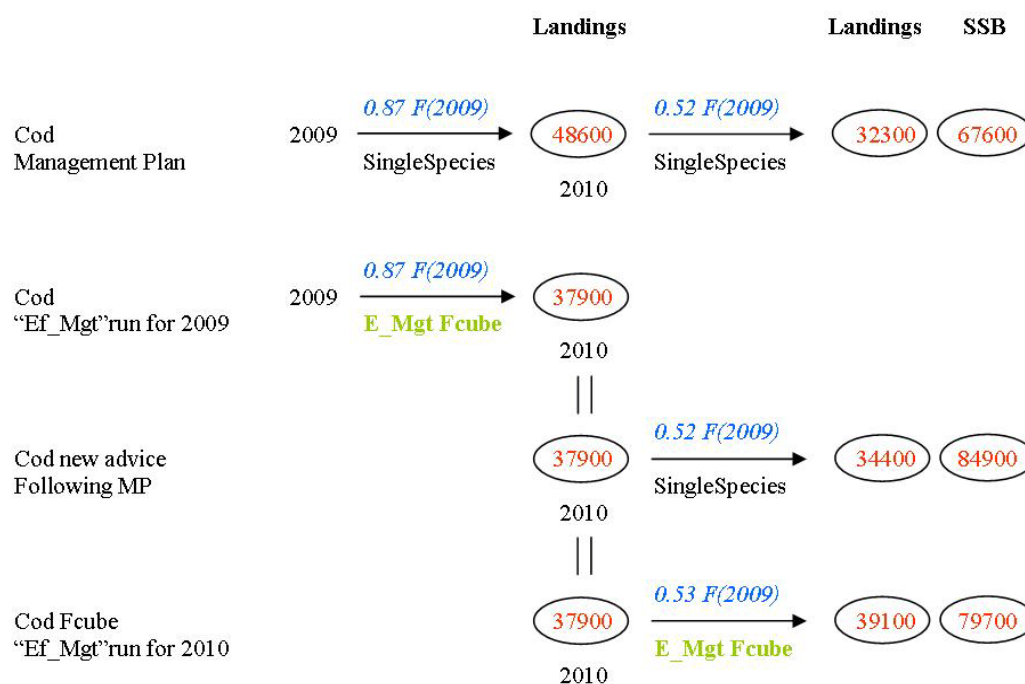
4.2.2.2 Relative stability

As a cross check, the landings by national fleets were summed over nation for each scenario, and the share by country was compared with the initial proxy for relative stability used as input to the model (Figures 4.2.2.2.1 and 4.2.2.2.2). The results show only minor deviations across all scenarios, indicating that the Fcube model did not lead to violation of the underlying hypothesis of relative stability in the TAC sharing (quotas) across nations.

4.2.2.3 Fcube analyses for the TAC year (2011)

The full overview of the runs up to 2011 is presented in Tables 4.2.2.3.1. and 4.2.2.3.2 and Figures 4.2.2.3.1 and 4.2.2.3.2.

The Fcube outputs for 2011 are quite comprehensive and their interpretation is not easy. An example of interpretation is given in the scheme below to aid understanding of the advice tables. The example follows the landings results for the cod stock in the Fcube **Ef_Mgt** scenario under the Management Plan advice approach:



Green color - Bold: This option is the Fcube run

Blue color - Italic: Fishing mortality factor relative to F2009

Red numbers in ○ : Resulting TAC or catch from table 4.2.2.3.2

In this example, the baseline run, which follows the single-stock ICES advice, assumes landings of 48600 tonnes in 2010 (corresponding to a 13% reduction in F from F2009 to F2010 following the Management Plan), and 32300 tonnes in 2011 applying a 20% TAC reduction from the 2010 TAC. The resulting SSB in 2012 is estimated to be 67600 tonnes. However, assuming that the effort restrictions imposed for 2010 on TR1, TR2 and BT2 (25% reduction) are applied, then the 2010 landings are estimated at 37900 tonnes, i.e. 22% less than assumed in the baseline. If this was the case, then the TAC advice for 2011 could be set to 34400 tonnes in order to comply with the single species advice in 2011, i.e. an increase of 7% compared to the single-species advice. The resulting SSB in 2012 is estimated to be 84900 tonnes, 26% higher than the resulting SSB following the single species advice according to the cod Management Plan.

If again we assumed that the fleets would fish in line with the effort reductions in 2011 (10% reduction for TR1, TR2 and BT2), then the landings in 2011 would be estimated at 39100 tonnes, i.e. 21% above the initial single-stock baseline and 14% above the landings corresponding to the Management Plan. While the Single-Stock advice estimates an SSB level around 67600 tonnes by 2012 under full compliance with the MP, the **Ef_Mgt** Fcube scenario (following the effort reduction from the Management Plan) estimates SSB in 2012 as high as 79700 tonnes.

Considering the results tables with respect to all species, the first set of results to investigate is the sensitivity of the single-stock advice to the Fcube hypotheses applied to the intermediate year, i.e. what happens if we maintain the same single-stock tar-

get for 2011 as in the current advice, but change the 2010 hypotheses (Block D in the output tables compared to the 2011 Baseline in Block C). Due to TAC constraints included in the MP for most stocks, the differences are not very large (usually less than +/-10% changes compared to the single-stock forecast). Only for whiting can this make a very significant difference in advice. This is due to the absence of an agreed MP and reference points for whiting. For this stock, the advice is based on the rule that “SSB must not decrease”, i.e. $SSB_{2012} = SSB_{2010}$. Given the early growth and maturing of whiting, the estimate of SSB in 2012 is extremely sensitive to the hypotheses of the intermediate year, and catch reductions in 2010 (e.g. from 26800 in the baseline to 17600 in the **Ef_Mgt** scenario, i.e. -34%, block C) lead to increase in SSB in 2011 (from 173 000 t in the baseline to 186 000 t, e.g. +8%, block F), and thus increased catches in 2011 to bring the 2012 SSB back to the 2010 level (2011 catches of 21800 t in the **Ef_Mgt** scenario – block D-, against 14200 t in the 2011 baseline in block C, i.e. +54%). This example underlines the major issue that the current basis for whiting advice is not robust to the various hypotheses and sources of uncertainties.

The second set of results to investigate is the difference between the potential 2011 catches considering mixed-fisheries interactions during both 2010 and 2011 (block C), the single-species advice (2011 baseline in block C and horizontal lines in Figures 4.2.2.3.1 and 4.2.2.3.2) and the mixed-fisheries advice accounting for single species Management Plans (Block D). This provides estimates of potential over/under shooting of 2011 TACs due to mixed-fisheries interactions.

In both the MP and MSY Advice Approach, the outcomes of the cod scenarios are very close to the outcomes of the **min** scenario, indicating that the cod stock is the most limiting stock for 2011, and that reductions in effort are needed if the cod advice is to be followed. The fact that 2011 catches in the **cod** scenario are even lower than in the **min** scenario in the MSY figure is because 2010 catches were lower in the **min** scenario, thus leading to a slightly higher cod biomass level in 2011 and thus larger 2011 catches for the same target F compared to the **cod** scenario.

The drastic F reductions in the MSY transition framework (target $F = 0.24$ for cod in 2011) are unlikely to be realised under the current effort, and even under the hypotheses of large effort reductions following the effort management plan.

The differences are less extreme under the MP advice approach, indicating that the proper implementation of the simulated effort reductions would bring the fisheries almost at the level (estimated $F_{bar}=0.45$) of the expectation of the cod management plan (target $F=0.44$), but with potentially large catch undershooting for all other stocks compared to the single-stock advice (around -40% for haddock and plaice, -60% for all *Nephrops* and -around 20-30% for sole and saithe), (Table 4.2.2.3.2).

These results are now used to form the basis of mixed fisheries advice for the North Sea in Annex 4 of this report.

5 Conclusions and Recommendations

The first meeting of WGMIXFISH has produced a North Sea Mixed Fisheries advice (Annex 4) and associated North Sea Mixed Fisheries Annex (Annex 5) for use by the ACOM advice drafting group.

No methodological problems were encountered with the Fcube package, but issues were encountered with respect to data submissions and non-standard approaches in single species assessment forecasting. Late and/or incomplete submission of data meant the dataset for the Fcube software was only completed at the end of the first day of the meeting. Cross checking of the 'baseline' run results against single species assessment forecasts was still taking place on the last day of the meeting.

The type of data required for the Fcube analysis is fundamentally similar to the data requested for effort and catch analysis by STECF. In an attempt to reduce the workload on national institutes the data call for this WG was made as similar as possible to the STECF data call but with different length categories. STECF economic data is collected according to EU DCF categories and the mixed fisheries methodology has the potential to include economic parameters and economics theory (see ICES 2009a for a full description). For WGMIXFISH, vessel length categories were therefore aligned to the DCF categories. It was also considered important to receive data for *Nephrops* split according to the functional units defined for that species. The data raising methods and resources available to different countries vary but for nations reliant on more manual methods of data raising these key differences in data call meant the aim of reducing workload was not achieved. The scenarios chosen for inclusion in the mixed fisheries advice annex did not include any making use of economic data. The working group recommends to the EU commission that metier classes be made compatible between the effort, catch and economic datasets requested of nations by STECF as soon as possible. In the meantime, a debate is needed intersessionally as to whether a data call specification less similar to the STECF effort data call but considerably simplified would facilitate more timely and complete data submissions. The working group also considers that future working groups should be held over five days.

To increase trust in the results from alternative scenarios it is considered important for the Fcube code to reproduce as exactly as possible the single species projections in the first instance. Cross checking the 'baseline' run exposed detailed differences in short term forecast methodology between species. These differences were not imposed by the use of different software. It became clear there is not a universal consensus on the best – or standard – approach e.g. to scaling a mean selection pattern to terminal year mean F. Unless alternative approaches are pedantically explained in single species stock annexes it is difficult and time consuming for the forecast to be reproduced in the Fcube code. The WG therefore recommends the next ICES WGCHAIRS meeting agree guidelines to achieve consistency in short term forecast methodology between stocks.

The analysis of two advice approaches (out of a potential 3) and five Fcube scenarios leads to a very data rich set of results. The **max** and **min** scenarios were included to bracket the space of potential catch and SSB outcomes but for most fleets are considered unrealistic scenarios. The effect of fleet behaviours according to the scenarios on

- The TAC set for 2011 (assuming perfect knowledge of catches in the intermediate year),
- The amount caught compared to single species TAC recommendations,

- The SSB remaining at the start of 2012,

all need to be considered when reviewing the results of mixed fisheries analysis and this process will continue beyond this WG. However, some initial conclusions are that

If one assumes current effort limits are limiting and applies a straightforward reduction in effort on controlled gears equal to the reductions in effort limits introduced in Council Regulation (EU) 23/2010 (**Ef_Mgt** scenario) the SSB in 2012 of all whitefish species considered is higher than when assuming the cod quotas allowed under the cod long term management plan are adhered to (**cod** scenario). In many cases catches in 2011 are also higher. This is because catches in 2010 under the **Ef_Mgt** scenario are below those from the **cod** scenario and resultant SSBs in 2011 higher. Refinement of the assumptions behind the **Ef_Mgt** scenario may be needed but it is hoped the results indicate the degree of consistency between the TAC and effort strands of the cod long term management plan.

For some species the TAC set for 2011 using the single species advice approaches - assuming catches in the intermediate year according to the scenarios - can be quite consistent, demonstrating a robustness of the single species management advice to changes in assumption on catches in the intermediate year. By contrast, the SSBs resulting in 2012 can be quite different. This latter observation might suggest a lack of sensitivity of the single species advice approaches rather than robustness.

The exception to the above conclusion is whiting. Here the single species advice is to ensure SSB in 2012 is the same as SSB in 2010. This can be achieved assuming catches in the intermediate year according to the scenarios but TACs set for 2011 have to vary by a significant amount in order to do so.

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Table 1.2.1, Council regulations introducing and modifying fishing effort (days at sea) allowances in EU fisheries.

Year of application	Regulation
2003	(EC) No 2341/2002–Annex XVII
2004	(EC) No 2287/2003–Annex V
2005	(EC) No 27/2005–Annex IVa
2006	(EC) No 51/2006–Annex IIa
2007	(EC) No 41/2007–Annex IIa
2008	(EC) No 40/2008–Annex IIa
2009	(EC) No 43/2009–Annex IIa
2010	(EC) No 23/2010–Annex IIa

Table 1.2.2; Gear categories used in effort management in 2010 (regulations 1342/2008 and 23/2010)

Mesh size ranges used in Gillnet categories changed in 2007. The most recent categorisation is given here.

Gear group (2006-2008)	Code	Gear group 2009
Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls;	4av	TR1
Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls;	4aiv	TR1
Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls;	4aiii	TR2
Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls;	4aii	TR2
Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls.	4ai	TR3
Beam trawls with mesh sizes equal to or larger than 120mm	4biv	BT1
Beam trawls with mesh sizes equal to or larger than 80 mm and less than 90mm	4bi	BT2
Beam trawls with mesh sizes equal to or larger than 90 mm and less than 100mm	4bii	BT2
Beam trawls with mesh sizes equal to or larger than 100 mm and less than 120mm	4biii	BT2
Gillnets & entangling nets with mesh size less than 110mm	4ci	GN
Gillnets & entangling nets with mesh size greater than or equal to 110mm and less than 150mm	4cii	GN
Gillnets & entangling nets with mesh size greater than or equal to 150mm and less than 220mm	4ciii	GN
Gillnets & entangling nets with mesh size greater than or equal to 220mm	4civ	GN
Trammel Nets	4d	GT
Longlines	4e	LL

Table 3.1.1.1: Summary of the TACs and target Fs/harvest ratios resulting from the Advice Approaches considered by ICES. Target Fs are left justified; harvest ratios are right justified. Where a stock does not have a management plan the TAC following the Commission communication COM (2010) 241 was used. Advice Approaches used for MIXFISH forecasts are highlighted in bold.

Species	Transition to an MSY approach		Precautionary Approach		Management Plan / Policy paper	
	TAC	Target F / Harvest ratio	TAC	Target F / Harvest ratio	TAC	Target F / Harvest ratio
Cod IIIa-IV-VIIId	< 18 100 t	0.24	zero	0.00	< 32 240 t (MP)	0.48
Haddock IIIa-IV	< 36 000 t HC	0.30	< 74 000 t HC		< 36 000 t HC (MP)	0.30
Plaice IV	< 64 200 t	0.23	< 144 400 t	0.60	< 73 400 t (Pol)	0.27
Sole IV	< 13 800 t	0.33	< 15 500 t	0.38	< 13 600 t (MP)	0.32
Saithe IIIa-IV-VI	< 103 000 t	0.30	< 125 000 t	0.38	< 103 000 t (MP)	0.30
Whiting IV-VIIId	n/a ¹	0.15	< 12 700 t HC	0.15	n/a ¹	0.15
<i>Nephrops</i> in Botney Gut (FU 5)	Reduce landings from recent level ²	n/a	< 980 t	n/a	< 1051 t (Pol)	n/a
<i>Nephrops</i> in Farn Deep (FU 6)	< 1 600 t	11.2	n/a	n/a	< 1 600 t (Pol)	11.2
<i>Nephrops</i> Fladen Ground (FU 7)	< 13 300 t	10.2	n/a	n/a	< 13 300 t (Pol)	10.2
<i>Nephrops</i> in Firth of Forth (FU 8)	< 2 000 t	21.7	n/a	n/a	< 2 350 t (Pol)	24.5
<i>Nephrops</i> in Moray Firth (FU 9)	< 1 300 t	13.7	n/a	n/a	< 1 339 t (Pol)	13.7
<i>Nephrops</i> in Noup (FU 10)	n/a	n/a	n/a	n/a	< 139 t (Pol)	n/a
<i>Nephrops</i> in Norwegian Deep (FU 32)	Reduce landings from recent level ³	n/a	< 640 t	n/a	< 1 200 t (Pol)	n/a
<i>Nephrops</i> in Moray Firth (FU 33)	Reduce landings from recent level ⁴	n/a	< 1 200 t	n/a	< 1 327 t (Pol)	n/a
<i>Nephrops</i> in Other rectangles (NEPOTH)	< 1 900 t	n/a	n/a	n/a	< 2 022 t (Pol)	n/a

¹ Value adopted from the precautionary approach: 12 700 t HC

² Value adopted from the precautionary approach: 980 t

³ Value adopted from the precautionary approach: 640 t

⁴ Value adopted from the precautionary approach: 1 200 t

Table 3.2.2.1: Métiers consistent with the cod long term management plan and AER database.

Gear	Mesh Size	fleet	Métier
Gillnet			GN1
Pots		Static	OTH
Longlines			LL1
Trammel			GT1
Pelagic Trawl		Pelagic	OTH
Pelagic Seine			OTH
Demersale Seine	>=120	Dseine	TR1
	110-119		
	90-99		
	80_89		TR2
	70-79		
	16-31		TR3
Otter	>=120	Otter	TR1
	110-119		
	90-99		
	80_89		TR2
	70-79		
	16-31		TR3
Beam	>=120	Beam	BT1
	110-119		
	90-99		BT2
	80_89		
Dredge		Dredge	OTH

Table 3.2.2.1: Final fleet and métier categories used in the mixed fishery analysis. 4, 3AN and 7D refer to the area.

Fleet	Metier
BE_Beam	BT1.IV
	BT2.IV
	OTH
DK_Beam	BT1.IV
	OTH
DK_DSeine	OTH
	TR1.IV
DK_Otter<24	OTH
	TR1.IV
	TR2.3AN
	TR2.IV
DK_Otter>40	otter.IV
	TR3.IV
DK_Otter2440	OTH
	otter.IV
	TR1.IV
	TR2.IV
	TR3.IV
DK_Static	GN1.3AN
	GN1.IV
	GT1.IV
	OTH
EN_Beam	BT1.IV
	BT2.IV
	OTH
EN_Otter<24	OTH
	TR1.IV
	TR2.IV
EN_Otter>24	TR1.IV
	TR2.IV
EN_Static	GN1.IV
	OTH
FR_Otter	OTH
	TR1.IV
	TR2.7D
	TR2.IV
FR_Static	GT1.IV
	OTH

Fleet	Metier
GE_Beam	BT2.IV
	OTH
GE_DSeine	OTH
	TR1.IV
GE_Otter	TR1.3AN
	TR1.IV
	TR2.IV
NL_Beam<24	BT2.IV
	OTH
NL_Beam>40	BT2.IV
	OTH
NL_Beam2440	BT2.IV
	OTH
NL_Otter	OTH
	otter.IV
	TR2.IV
NO_Otter>24	OTH
	TR1.IV
SC_Beam	BT1.IV
	BT2.IV
SC_DSeine	TR1.IV
SC_Otter<12	OTH
	otter.IV
	TR2.IV
SC_Otter>24	TR1.IV
	TR2.IV
SC_Otter1224	OTH
	TR1.IV
	TR2.IV
SC_Static	OTH
	pots.IV
SW_Otter	OTH
	TR1.IV
	TR2.3AN
OTH_OTH	OTH

Table 4.2.1.1a: Baseline run outputs from the Fcube FLR package, Management plan runs.

Management plan	COD	HAD	PLE	POK	SOL	WHG
2010						
Fbar	0.74	0.23	0.24	0.29	0.36	0.33
FmultVsF09	0.87	1	1	1	1	1
landings	48586	31115	61795	10301	14557	26837
ssb	54764	19637	43524	23286		17992
		4	8	0	32944	2
2011						
Fbar	0.44	0.29	0.27	0.3	0.32	0.15
FmultVsF09	0.52	1.22	1.12	1.03	0.9	0.46
landings	32320	35782	73370	10367	13578	14230
ssb	52938	21297	48182	22397		17253
		8	1	6	35283	8
2012		21305	51769	21935		17992
ssb	67631	1	8	5	36861	2

Management plan	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP3 2	NEP3 3	NEPOT H
2010									
Harvest rate		0.19	0.1	0.29	0.12				
FmultVsF09		1	1	1	1				
landings	720	2710	13321	2662	1066	89	477	1162	2482
2011									
Harvest rate		0.11	0.1	0.26	0.15				
FmultVsF09		0.59	1	0.88	1.26				
landings	1051	1600	13300	2350	1339	139	1200	1327	2022

Table 4.2.1.1b: Baseline run outputs from the Fcube FLR package, MSY runs.

MSY	COD	HAD	PLE	POK	SOL	WHG
2010						
Fbar	0.85	0.23	0.24	0.29	0.36	0.33
FmultVsF09	1	1	1	1	1	1
landings	53434	31115	61795	103012	14557	26837
ssb	54764	196374	435248	232860	32944	179922
2011						
Fbar	0.24	0.3	0.23	0.3	0.33	0.15
FmultVsF09	0.28	1.28	0.97	1.03	0.92	0.46
landings	17475	37445	64319	103673	13870	14230
ssb	47709	212978	481821	223976	35283	172538
2012						
ssb	75127	210926	532291	219355	36586	179922

MSY	NEP5	NEP6	NEP7	NEP8	NEP9	NEP10	NEP32	NEP33	NEPOTH
2010									
Harvest rate		0.19	0.1	0.29	0.12				
FmultVsF09		1	1	1	1				
landings	720	2710	13321	2662	1066	89	477	1162	2482
2011									
Harvest rate		0.11	0.1	0.22	0.14				
FmultVsF09		0.58	1	0.75	1.18				
landings	980	1560	13276	1995	1260		640	1200	1900

Table 4.2.1.2: Comparison between baseline run and ICES advice for finfish. Figures for 2010 compare results from the baseline run - that use the same assumptions for F in the intermediate year as the forecasts leading to ICES advice – to the ICES intermediate year results.

Management plan		COD	HAD	PLE	POK	SOL	WHG
2010	landings						
	Baseline	49000	31000	62000	103000	15000	27000
	ICES	48000	31000	62000	103000	15000	24000
	% difference	-2.0%	0.0%	0.0%	0.0%	0.0%	-11.1%
2011	landings						
	Baseline	32000	36000	73000	103000	14000	14000
	ICES	32000	36000	73000	103000	14000	14000
	% difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MSY		COD	HAD	PLE	POK	SOL	
2010	landings						
	Baseline	53400	31100	61800	102600	14600	
	ICES	52900	31000	61800	103000	14600	
	% difference	-0.9%	-0.3%	0.0%	0.4%	0.0%	
2011	landings						
	Baseline	17500	37400	64300	103100	13900	
	ICES	18100	36000	64200	103000	13800	
	% difference	3.4%	-3.7%	-0.2%	-0.1%	-0.7%	

Table 4.2.1.3: Comparison between baseline run and ICES advice for *Nephrops* No values are given in the advice year for *Nephrops* FUs that do not receive an absolute abundance estimate. No 'ICES advice' values are given for *Nephrops* in the intermediate year because the baseline run uses values based on recorded landings in the previous year which can vary significantly from the advice for each FU.

Management plan		NEP 5	NEP 6	NEP 7	NEP 8	NEP 9	NEP1 0	NEP3 2	NEP3 3	NEPOT H
2011	landings									
	Baseline	1100	1600	13300	2400	1300	100	1200	1300	2000
	ICES	1100	1600	13300	2400	1300	100	1200	1300	2000
	% difference	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MSY		NEP 5	NEP 6	NEP 7	NEP 8	NEP 9	NEP1 0	NEP3 2	NEP3 3	NEPOT H
2011	landings									
	Baseline	1000	1600	13300	2000	1300		600	1200	1900
	ICES	1000	1600	13300	2000	1300		600	1200	1900
	% difference	0.0%	0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%

Table 4.2.2.1a : FMSY advice approach. Results of running Fcube scenarios on intermediate year.

	COD	HAD	PLE	POK	SOL	WHG				
TAC2010	40400	38200	63800	118000	14100	12900*				
baseline	53434	31115	61795	103012	14557	26837				
max	72105	57566	186640	150181	39665	38420				
min	41174	28879	56561	78653	12677	20924				
cod	53434	38874	78541	120652	17465	30424				
sq_E	49432	37940	63661	102489	14053	26449				
Ef_Mgt	37888	23795	44688	86175	10212	17573				
*Whiting TAC for area IV only										
	NEP10	NEP32	NEP33	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH	
TAC2010	89	477	1162	720	2710	13321	2662	1066	2482	
baseline	89	477	1162	720	2710	13321	2662	1066	2482	
max	105	564	1374	851	2745	14400	4303	1908	2934	
min	61	329	802	497	1655	8721	2218	1040	1712	
cod	84	450	1097	679	2359	11349	3393	1547	2342	
sq_E	78	418	1018	630	2039	10982	2897	1389	2174	
Ef_Mgt	46	246	600	372	1192	6238	1874	900	1282	

Table 4.2.2.1b : MP advice approach. Results of running Fcube scenarios on intermediate year.

	COD	HAD	PLE	POK	SOL	WHG
TAC2010	40400	38200	63800	118000	14100	12900*
baseline	48586	31115	61795	103012	14557	26837
max	71806	57427	186415	148190	39639	37386
min	41148	28809	56560	78650	12677	20901
cod	48586	34328	69450	107496	15620	26978
sq_E	49432	37940	63661	102489	14053	26449
Ef_Mgt	37888	23795	44688	86175	10212	17573
*Whiting TAC for area IV only						

	NEP10	NEP32	NEP33	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH
TAC2010	89	477	1162	720	2710	13321	2662	1066	2482
baseline	89	477	1162	720	2710	13321	2662	1066	2482
max	105	564	1374	851	2745	14400	4303	1908	2934
min	61	329	802	497	1655	8721	2218	1040	1712
cod	73	391	955	591	2052	9874	2952	1346	2038
sq_E	78	418	1018	630	2039	10982	2897	1389	2174
Ef_Mgt	46	246	600	372	1192	6238	1874	900	1282

Table 4.2.2.3.1. Results of Final Fcube runs. Transition to F_{MSY} advice approach.

			COD	HAD	PLE	POK	SOL	WHG		NEP10	NEP32	NEP33	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH	Nep_Total		
Fbar	2010	baseline	0.85	0.23	0.24	0.29	0.36	0.33		-	-	-	-	0.19	0.1	0.29	0.12	-	A		
	2011	baseline	0.24	0.3	0.23	0.3	0.33	0.15		-	-	-	-	0.11	0.1	0.22	0.14	-			
FmultVsF09	2010	baseline	1	1	1	1	1	1		-	-	-	-	1	1	1	1	-	B		
		cod	1	1.28	1.31	1.21	1.25	1.16		-	-	-	-	0.87	0.85	1.27	1.45	-			
		Ef_Mgt	0.62	0.75	0.7	0.81	0.66	0.62		-	-	-	-	0.44	0.47	0.7	0.84	-			
		max	1.67	2.03	3.92	1.59	4.65	1.53		-	-	-	-	1.01	1.08	1.62	1.79	-			
		min	0.69	0.92	0.91	0.73	0.85	0.76		-	-	-	-	0.61	0.65	0.83	0.98	-			
	2011	sq_E	0.89	1.25	1.03	0.99	0.96	0.98		-	-	-	-	0.75	0.82	1.09	1.3	-			
		baseline	0.28	1.28	0.97	1.03	0.92	0.46		-	-	-	-	0.58	1	0.75	1.18	-			
		cod	0.28	0.36	0.37	0.34	0.35	0.33		-	-	-	-	0.24	0.24	0.36	0.41	-			
		Ef_Mgt	0.53	0.59	0.59	0.75	0.56	0.51		-	-	-	-	0.34	0.35	0.58	0.7	-			
		max	1.52	1.83	4.66	1.11	5.74	1.43		-	-	-	-	0.96	1.03	1.54	1.7	-			
2011	min	0.28	0.36	0.37	0.34	0.35	0.33		-	-	-	-	0.24	0.24	0.35	0.4	-				
	sq_E	0.89	1.25	1.03	0.99	0.96	0.98		-	-	-	-	0.75	0.82	1.09	1.3	-				
	landings	2010	baseline	53400	31100	61800	103000	14600	26800		90	480	1200	720	2700	13300	2700	1100	2500	24790	C
			cod	53400	38900	78500	121000	17500	30400		80	450	1100	680	2400	11300	3400	1500	2300	23210	
			Ef_Mgt	37900	23800	44700	86200	10200	17600		50	250	600	370	1200	6200	1900	900	1300	12770	
max			72100	57600	187000	150000	39700	38400		110	560	1400	850	2700	14400	4300	1900	2900	29120		
min			41200	28900	56600	78700	12700	20900		60	330	800	500	1700	8700	2200	1000	1700	16990		
sq_E		49400	37900	63700	102000	14100	26400		80	420	1000	630	2000	11000	2900	1400	2200	21630			
2011		baseline	17500	37400	64300	104000	13900	14200		-	640	1200	980	1600	13300	2000	1300	1900	22920	D	
	cod	17500	10900	24100	36200	5500	9900		30	140	340	210	660	3200	960	440	720	6700			
ssb	2010	Ef_Mgt	39100	18900	44000	83600	9900	16900		40	210	510	320	920	4700	1500	740	1100	10040		E
		max	39900	43600	118000	94800	21300	34100		110	590	1400	880	2600	13700	4100	1800	3000	28180		
		min	21600	11500	26600	41200	6100	10800		30	140	340	210	660	3200	940	430	720	6670		
		sq_E	47800	35100	67800	101000	14500	28100		90	460	1100	690	2000	11000	2900	1400	2400	22040		
		Ld_FMSY	2011	cod	17500	35800	59300	98100	12900	15900		-	640	1200	980	1600	13300	2000	1300	1900	
Ef_Mgt	22700			39000	68600	109000	15300	21800		-	640	1200	980	1600	13300	2000	1300	1900	18200		
max	11300			32000	32900	88800	6000	9200		-	640	1200	980	1600	13300	2000	1300	1900	18200		
min	21600			37900	65300	111000	14500	22500		-	640	1200	980	1600	13300	2000	1300	1900	18200		
sq_E	18800			36000	63300	104000	14000	19200		-	640	1200	980	1600	13300	2000	1300	1900	18200		
ssb	2010	baseline	54800	196000	435000	233000	32900	180000											G		
		2011	baseline	47700	213000	482000	224000	35300	173000												
	2012	baseline	75100	211000	532000	219000	36600	180000										H			
		2011	cod	47700	204000	455000	208000	32500	168000												
	Ef_Mgt	64600	222000	510000	239000	39400	185000														
	max	28100	182000	288000	183000	12000	157000														
	min	61000	216000	490000	246000	37100	180000														
	sq_E	52000	205000	479000	224000	35800	173000														
	2012	cod	75100	236000	560000	262000	41700	182000													
		Ef_Mgt	79700	244000	605000	255000	44400	187000													
max		18300	170000	185000	180000	6400	142000														
min		93200	247000	606000	301000	45700	191000														
ssb_FMSY	2012	sq_E	49300	206000	522000	222000	36500	163000													
cod		75100	203000	503000	207000	34700	180000														
Ef_Mgt		98100	218000	565000	232000	39400	186000														
max		48100	185000	321000	185000	20100	180000														
min		93200	213000	543000	237000	37800	182000														
		sq_E	81000	204000	530000	220000	36900	180000													

Table 4.2.2.3.2. Results of Final Fcube runs. Management Plan advice approach.

			COD	HAD	PLE	POK	SOL	WHG	NEP10	NEP32	NEP33	NEP5	NEP6	NEP7	NEP8	NEP9	NEPOTH	Nep_Total				
Fbar	2010	baseline	0.74	0.23	0.24	0.29	0.36	0.33	-	-	-	-	0.19	0.1	0.29	0.12	-	A				
	2011	baseline	0.44	0.29	0.27	0.3	0.32	0.15	-	-	-	-	0.11	0.1	0.26	0.15	-					
FmultVsF09	2010	baseline	0.87	1	1	1	1	1	-	-	-	-	1	1	1	1	-	B				
		cod	0.87	1.11	1.14	1.05	1.09	1.01	-	-	-	-	0.76	0.74	1.11	1.26	-					
		Ef_Mgt	0.62	0.75	0.7	0.81	0.66	0.62	-	-	-	-	0.44	0.47	0.7	0.84	-					
		max	1.66	2.02	3.92	1.57	4.64	1.48	-	-	-	-	1.01	1.08	1.62	1.79	-					
		min	0.69	0.92	0.91	0.73	0.85	0.75	-	-	-	-	0.61	0.65	0.83	0.98	-					
	2011	sq_E	0.89	1.25	1.03	0.99	0.96	0.98	-	-	-	-	0.75	0.82	1.09	1.3	-					
		baseline	0.52	1.22	1.12	1.03	0.9	0.46	-	-	-	-	0.59	1	0.88	1.26	-					
		cod	0.52	0.67	0.68	0.63	0.65	0.6	-	-	-	-	0.45	0.44	0.66	0.76	-					
		Ef_Mgt	0.53	0.59	0.59	0.75	0.56	0.51	-	-	-	-	0.34	0.35	0.58	0.7	-					
		max	3.42	5.34	6.1	3.2	6.75	3.73	-	-	-	-	2.29	2.61	3.79	4.57	-					
		min	0.46	0.58	0.6	0.55	0.57	0.52	-	-	-	-	0.39	0.39	0.53	0.6	-					
		sq_E	0.89	1.25	1.03	0.99	0.96	0.98	-	-	-	-	0.75	0.82	1.09	1.3	-					
		landings	2010	baseline	48600	31100	61800	103000	14600	26800	90	480	1200	720	2700	13300	2700		1100	2500	24790	C
		cod	48600	34300	69400	107000	15600	27000	70	390	950	590	2100	9900	3000	1300	2000		20300			
Ef_Mgt	37900	23800	44700	86200	10200	17600	50	250	600	370	1200	6200	1900	900	1300	12770						
max	71800	57400	186000	148000	39600	37400	110	560	1400	850	2700	14400	4300	1900	2900	29120						
min	41100	28800	56600	78600	12700	20900	60	330	800	500	1700	8700	2200	1000	1700	16990						
sq_E	49400	37900	63700	102000	14100	26400	80	420	1000	630	2000	11000	2900	1400	2200	21630						
2011	baseline	32300	35800	73400	104000	13600	14200	140	1200	1300	1100	1600	13300	2400	1300	2000	24340					
cod	32300	20100	45100	66700	10000	18100	50	250	610	380	1200	5900	1800	810	1300	12300						
Ef_Mgt	39100	18900	44000	83600	9900	16900	40	200	500	310	920	4700	1500	740	1100	10010						
max	55300	99000	140000	207000	22800	68100	270	1400	3500	2200	6200	34800	10100	4900	7500	70870						
min	32700	18300	42100	64500	9500	16700	40	210	520	320	1100	5200	1400	640	1100	10530						
sq_E	47800	35100	67800	101000	14500	28100	80	440	1100	670	2000	11000	2900	1400	2300	21890						
Ld_MgtPlan	2011	cod	32300	36800	73400	102000	14200	18800	140	1200	1300	1100	1600	13300	2400	1300	2000	24340	D			
		Ef_Mgt	34400	39000	73400	109000	12000	21800	140	1200	1300	1100	1600	13300	2400	1300	2000	24340				
		max	32300	32500	54200	100000	16200	10100	140	1200	1300	1100	1600	13300	2400	1300	2000	24340				
		min	32800	37900	73400	111000	12300	22500	140	1200	1300	1100	1600	13300	2400	1300	2000	24340				
		sq_E	32300	36000	73400	104000	13300	19200	140	1200	1300	1100	1600	13300	2400	1300	2000	24340				
ssb	2010	baseline	54800	196000	435000	233000	32900	180000										E				
		2011	baseline	52900	213000	482000	224000	35300	173000													
		2012	baseline	67600	213000	518000	219000	36900	180000													
	2011	cod	52900	209000	469000	220000	34300	172000														
		Ef_Mgt	64600	222000	510000	239000	39400	185000														
		max	28400	182000	289000	184000	12000	159000														
		min	61000	216000	490000	246000	37100	180000														
		sq_E	52000	205000	479000	224000	35800	173000														
		cod	67600	229000	546000	248000	39200	175000														
		Ef_Mgt	79700	244000	605000	255000	44400	187000														
		max	4800	100000	154000	90800	5200	100000														
		min	80800	238000	580000	280000	42500	183000														
	sq_E	49300	206000	522000	222000	36500	163000															
	ssb_MgtPlan	2012	cod	67600	208000	500000	216000	35200	180000											F		
Ef_Mgt			84900	218000	557000	232000	42500	186000														
max			26400	185000	286000	177000	10800	180000														
min			80800	213000	530000	237000	39800	182000														
sq_E			66100	204000	513000	220000	37600	180000														

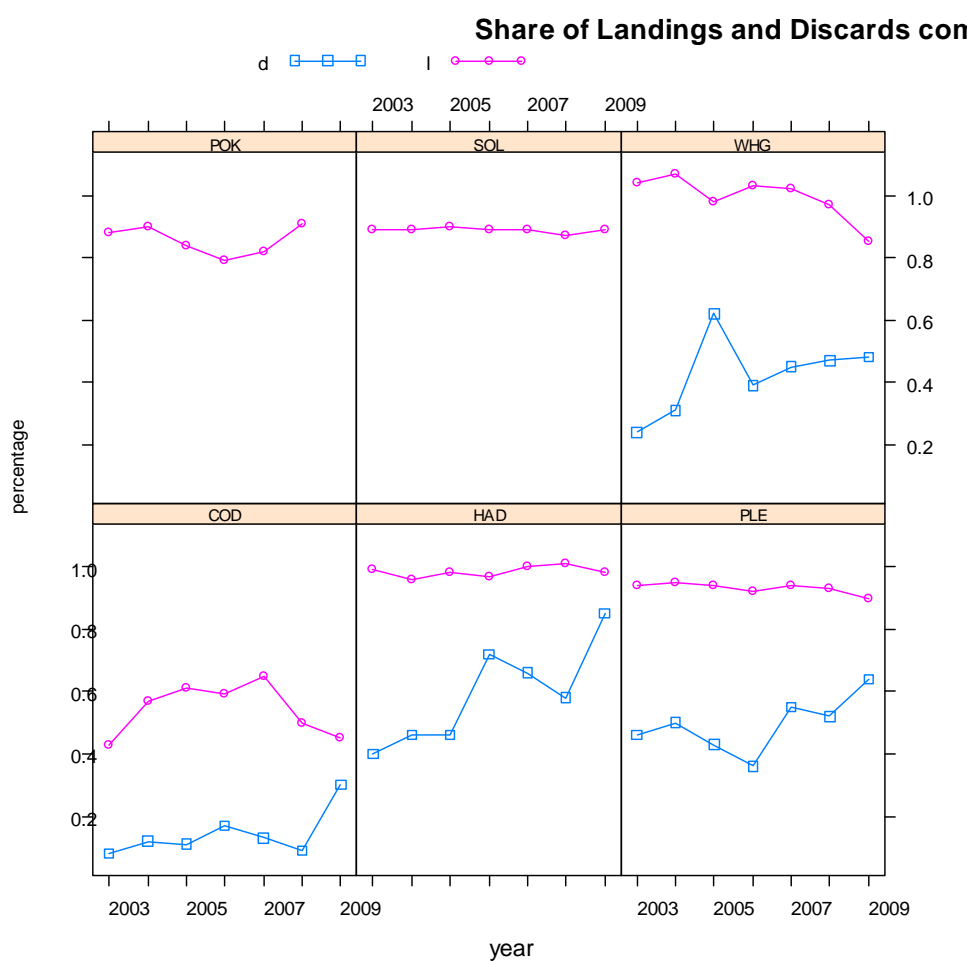


Figure 3.2.2.1. Ratio between the sum of landings and discards across fleets used in the MIXFISH analysis and the landings and discards estimated by the WGNSSK stock assessments. For cod the single species assessment applies a catch multiplier to supplied landings and discards totals; the catch multiplier in 2010 was 2.01.

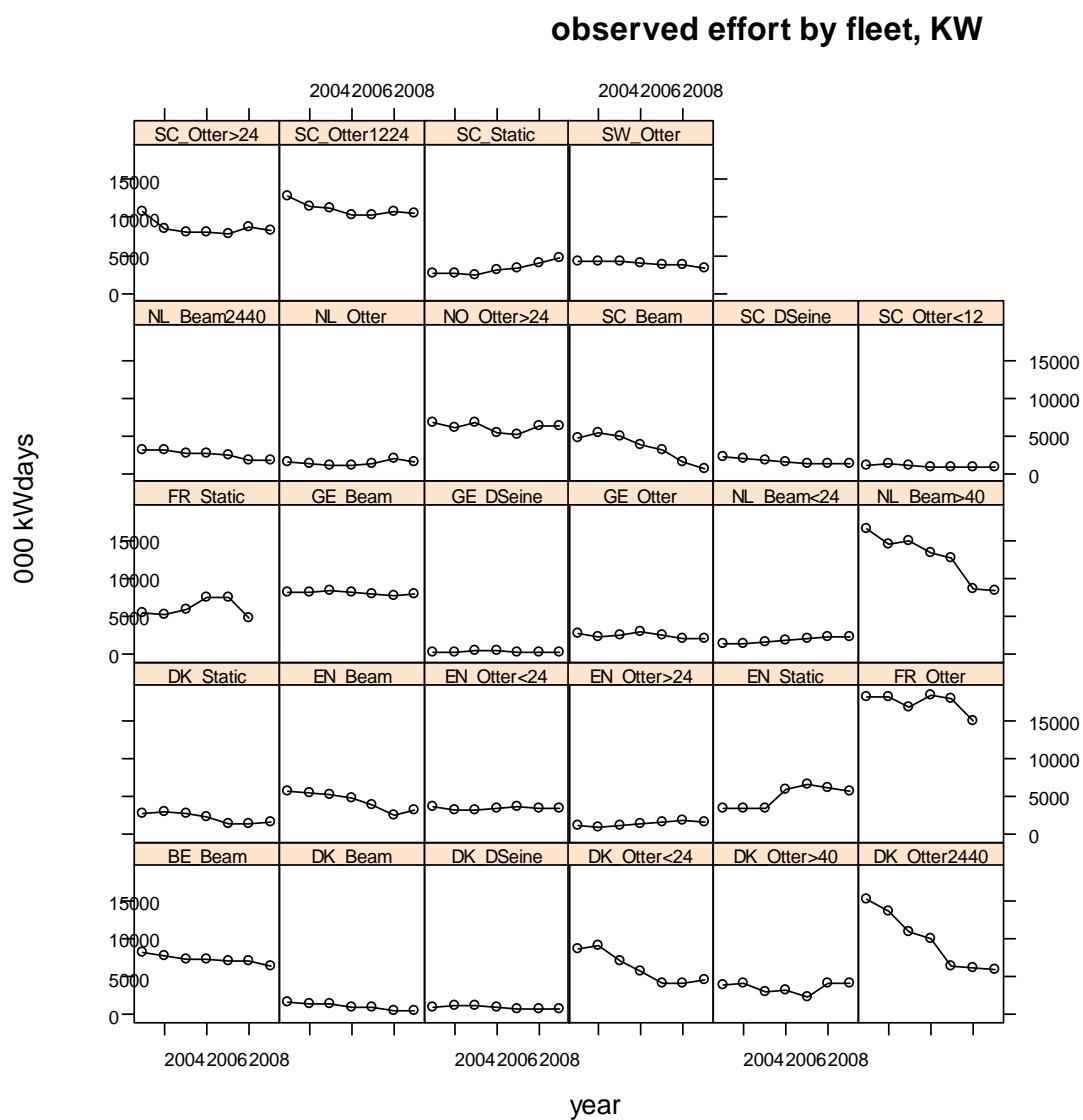


Figure 3.2.3.1 – Effort by fleet and year for the North Sea demersal fleets, in '000 KWdays. Data for French fleets from 2009 was not available and the data point is omitted; for Fcube projections French fleet values were assumed the same as values from 2008.

relative observed effort by fleet, KW

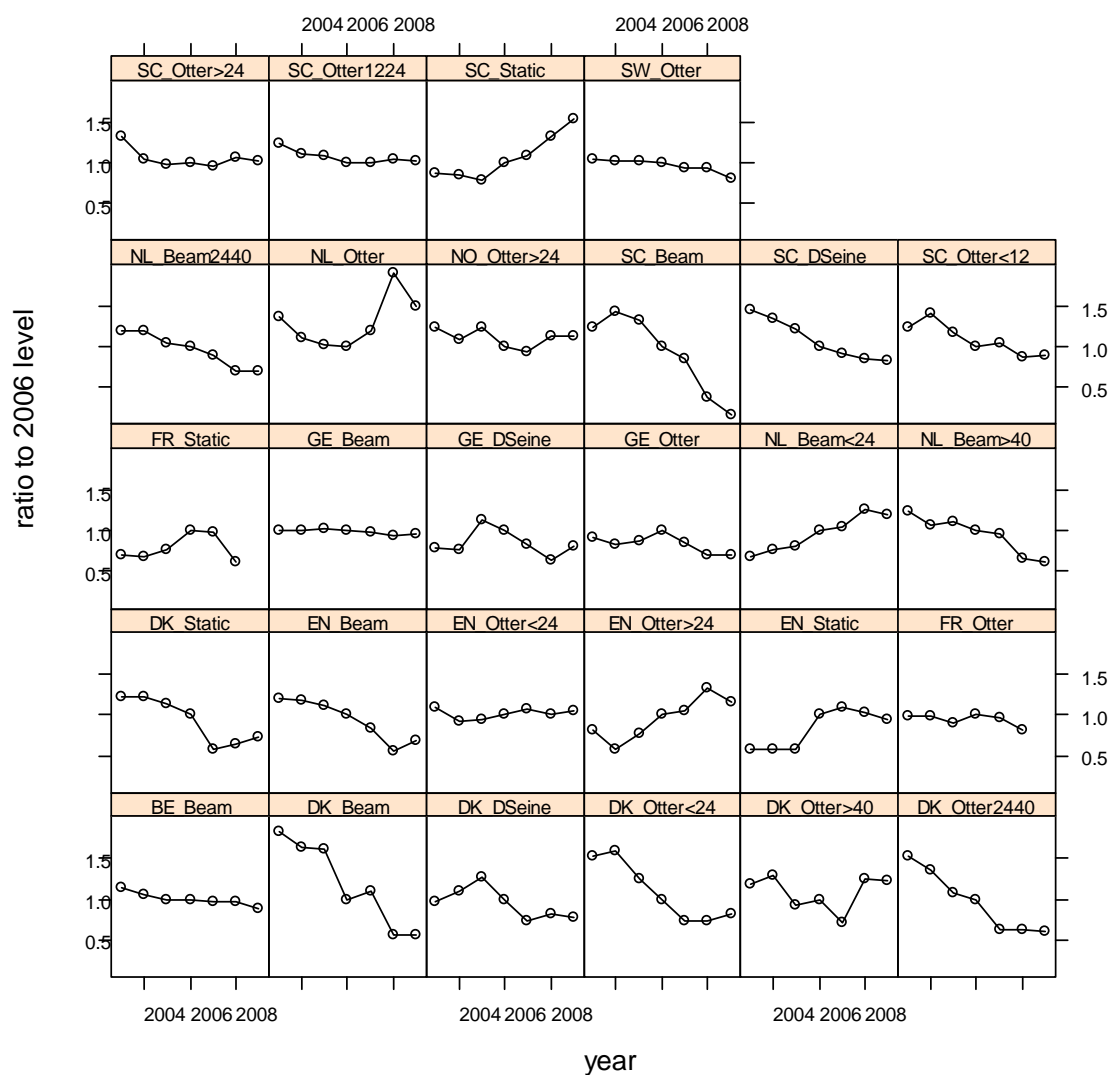


Figure 3.2.3.2 – Relative trends in effort (KW Days) by fleet and year for the North Sea demersal fleets. Data for French fleets from 2009 was not available and the data point is omitted; for Fcube projections French fleet values were assumed the same as values from 2008.

effshare by fleet and metier

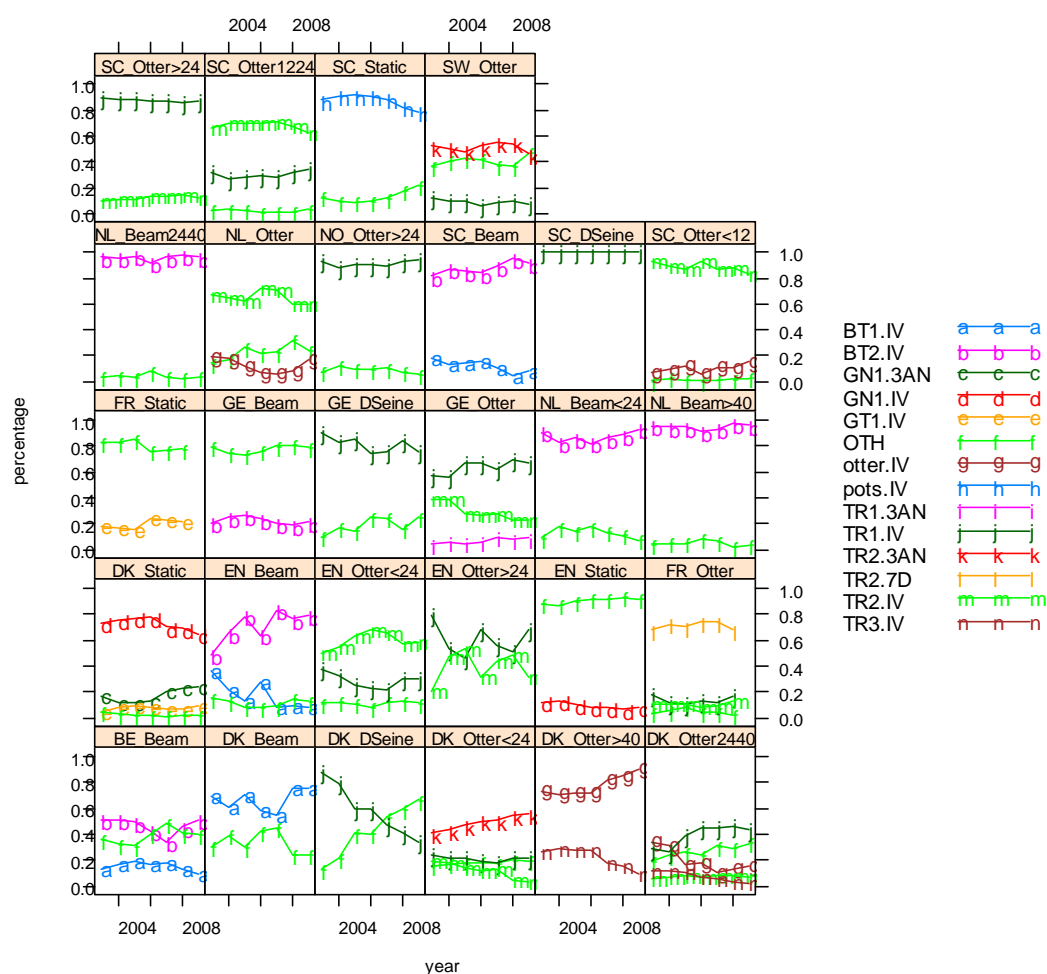


Figure 3.2.3.3 – Effort share (in proportion) by métier for each fleet.

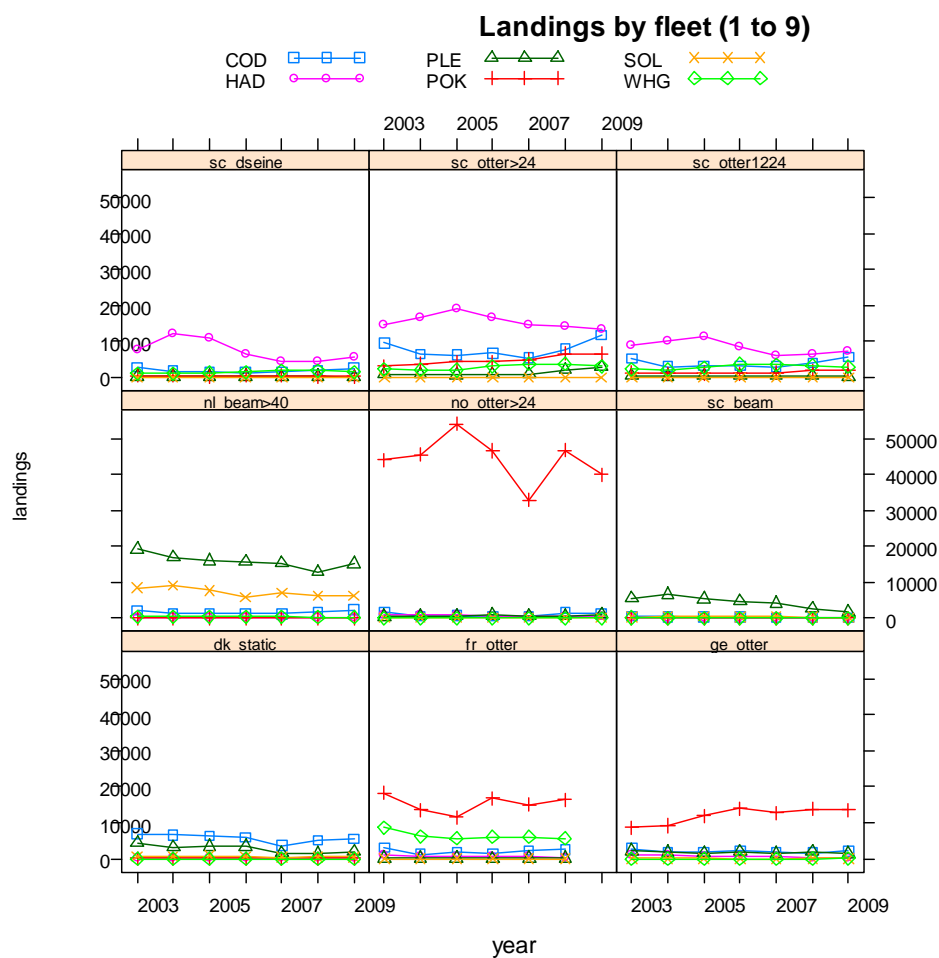


Figure 3.2.3.4. Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

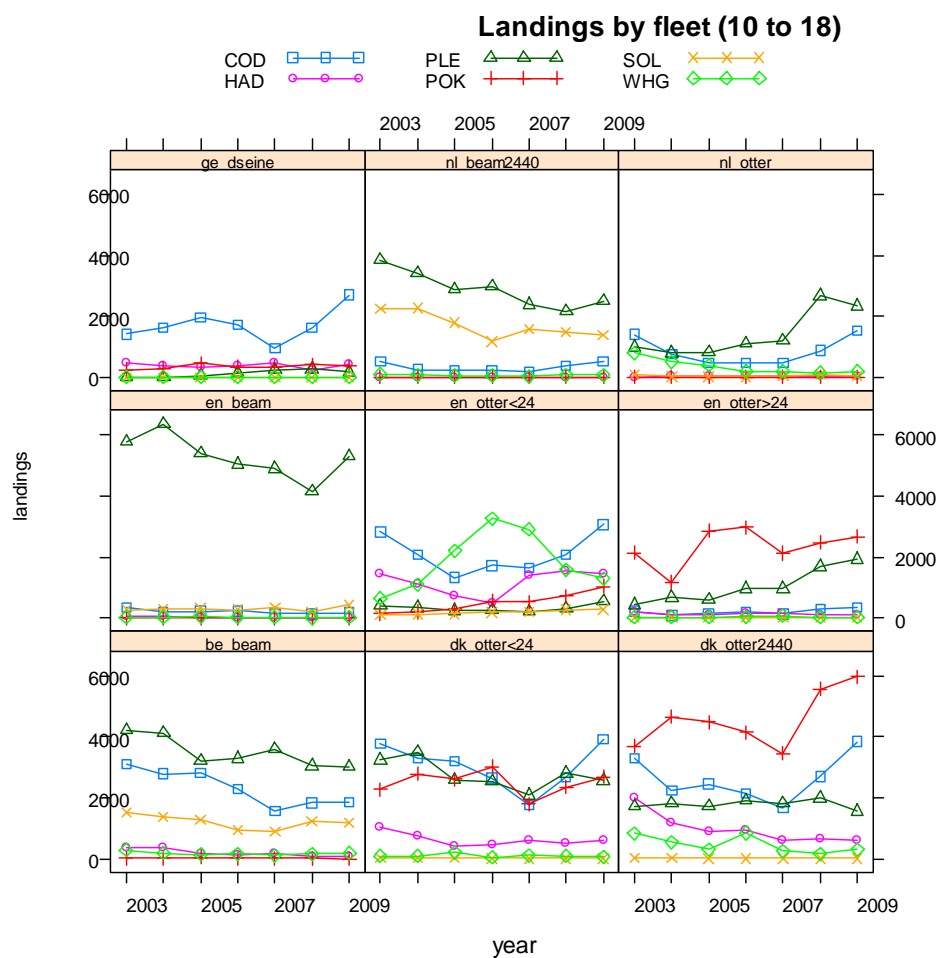


Figure 3.2.3.4 (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

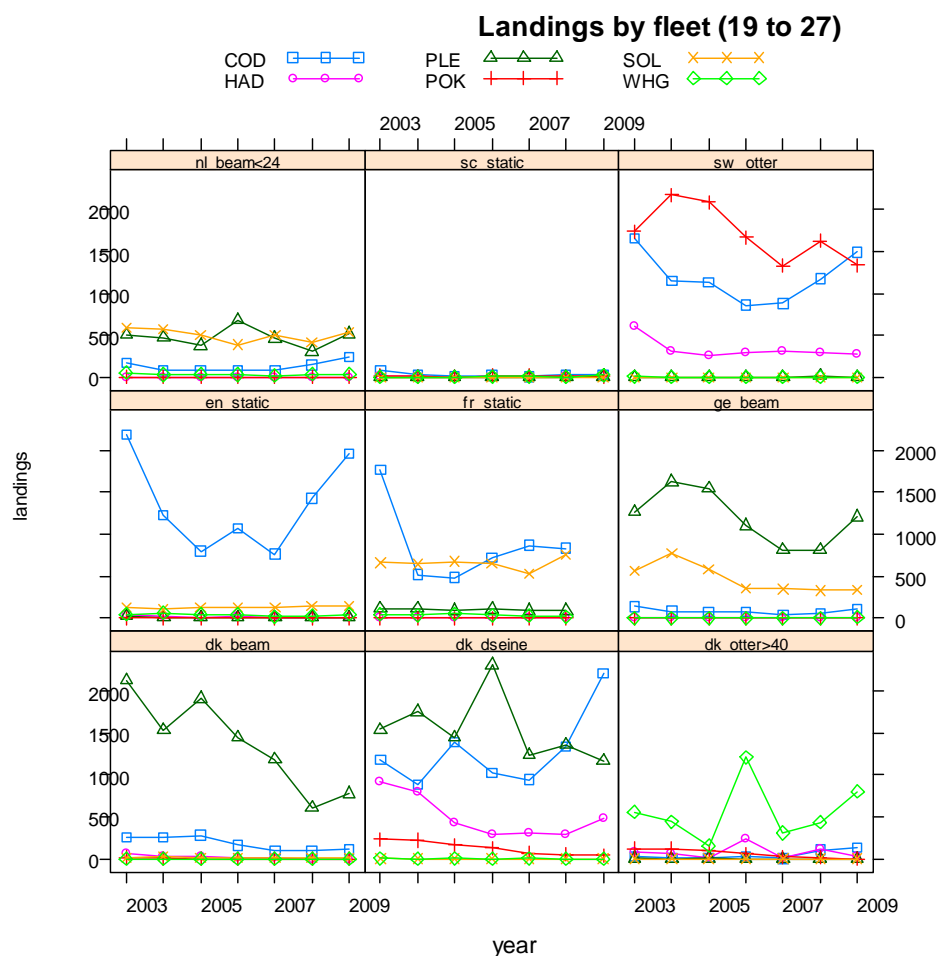


Figure 3.2.3.4 (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

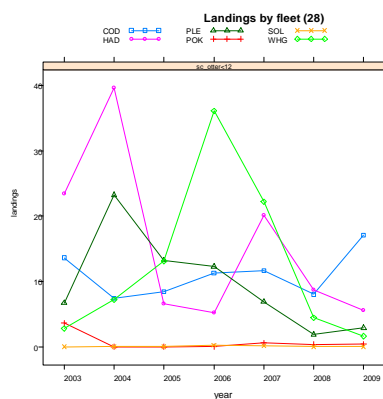


Figure 3.2.3.4 (cont). Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales.

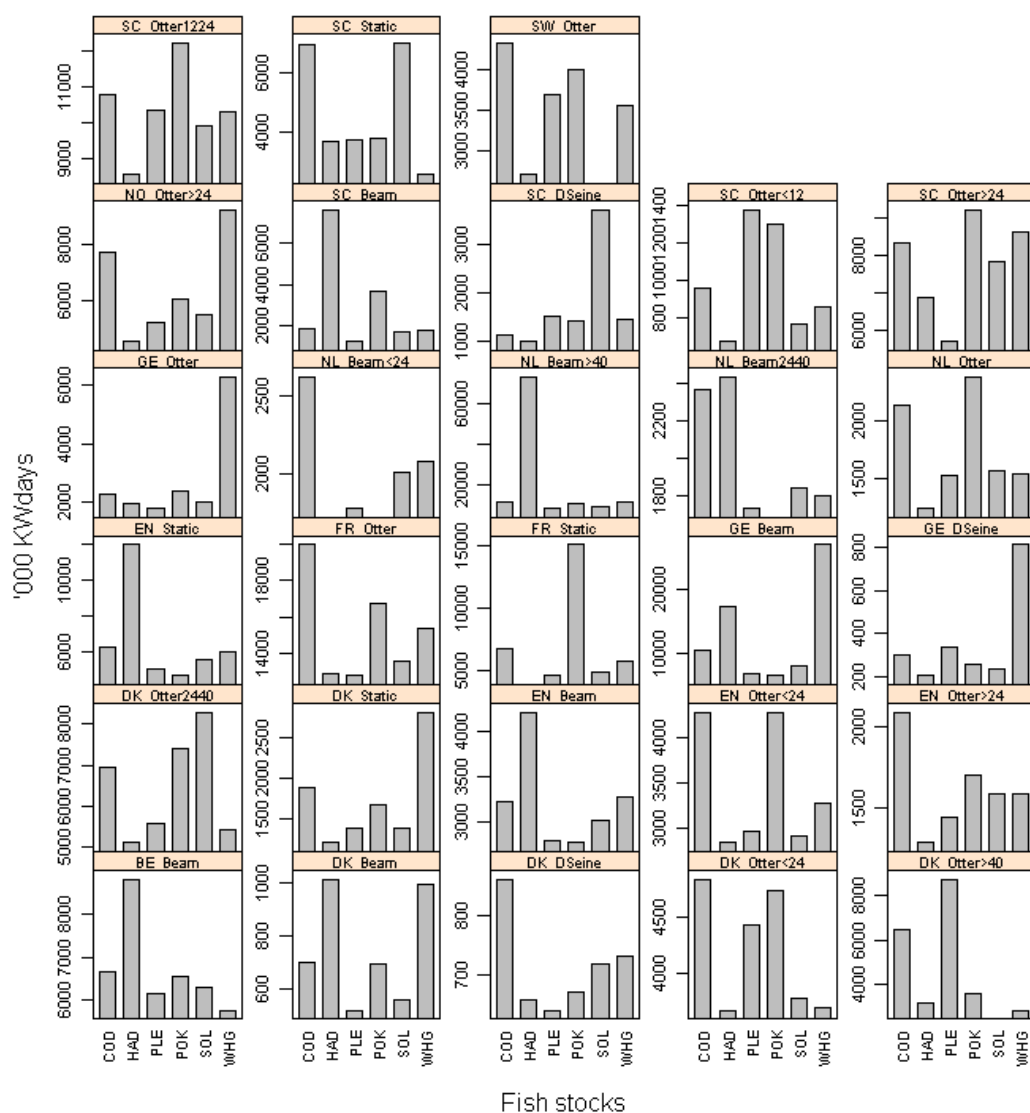


Figure 4.2.2.1.1. Intermediate year results. Single-Stock Target F in 2010; FMSY advice approach. Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2010 when applying the five scenarios. Finfish species.

2010 Effort corresponding to single-stock quota share, nep stocks

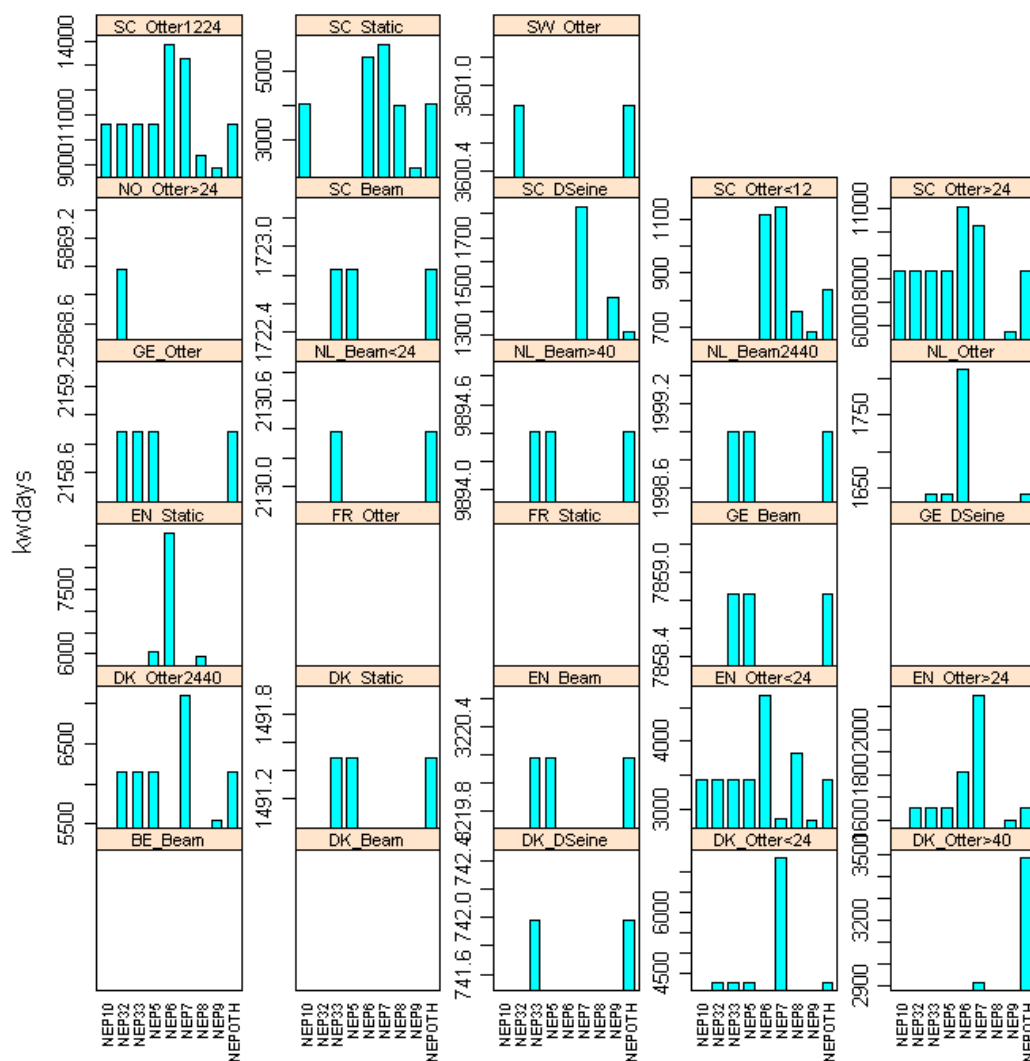


Figure 4.2.2.1.2. Intermediate year results. Single-Stock Target F in 2010; FMSY advice approach. Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2010 when applying the five scenarios. Nephrops FUs.

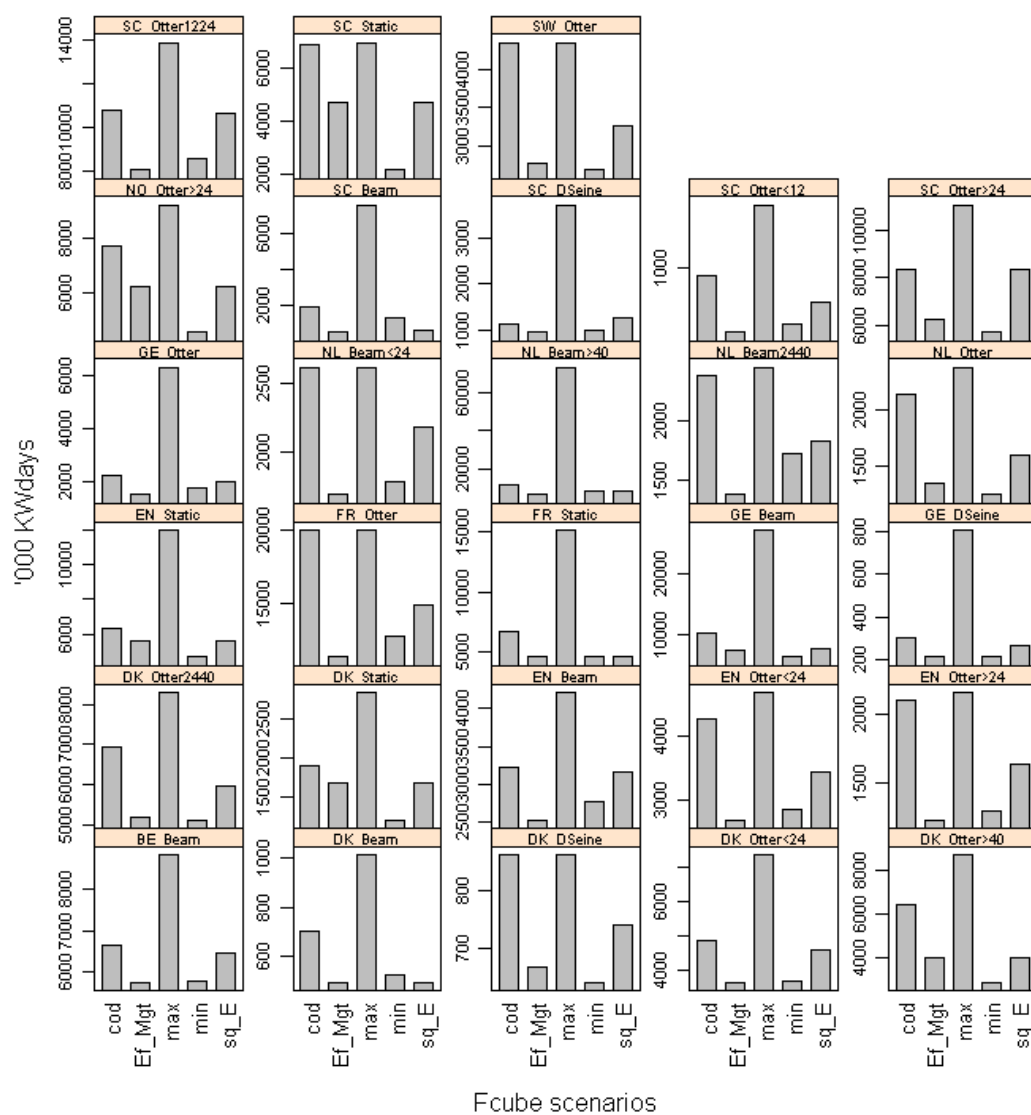


Figure 4.2.2.1.3. Intermediate year results. FMSY advice approach. Fcube estimates of effort by fleet implied by the Fcube scenarios in the intermediate year (2010).

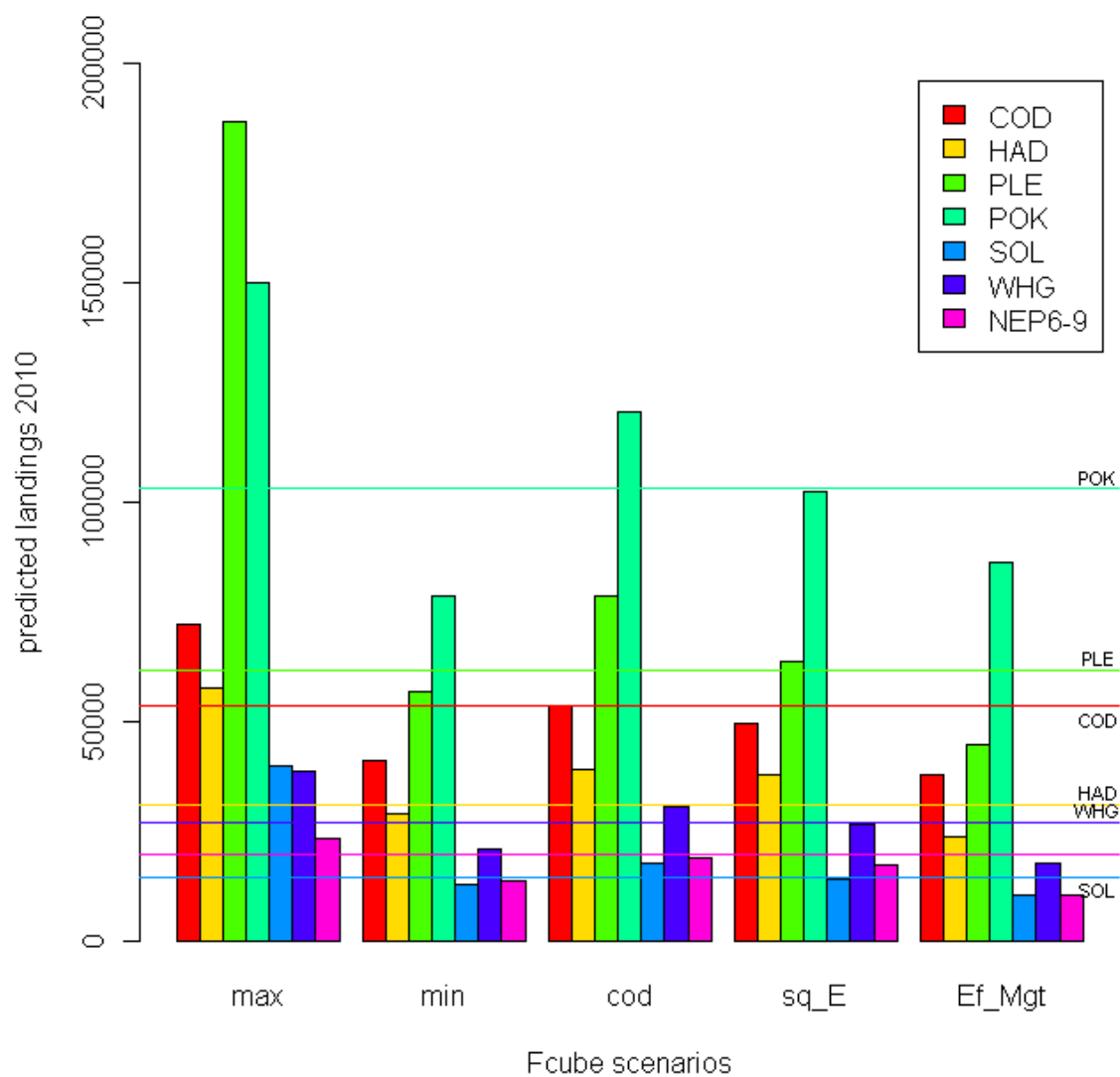


Figure 4.2.2.1.4. Intermediate year results. FMSY advice approach. Fcube estimates of landings by stock for the Fcube scenarios in the intermediate year (2010). Coloured horizontal lines correspond to the intermediate year assumptions for catch from the single species stock assessments (as reproduced by the 'baseline run').

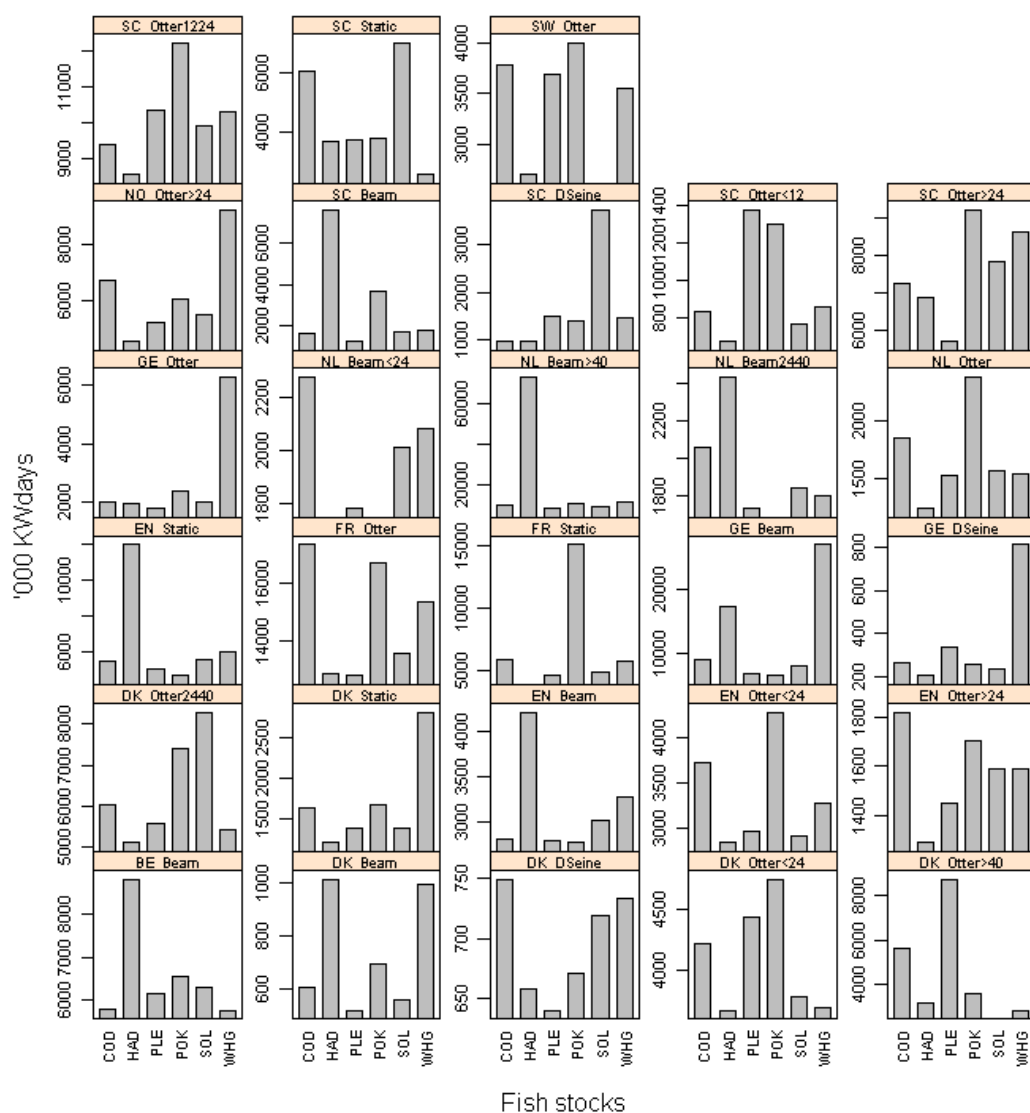


Figure 4.2.2.1.5. Intermediate year results. Single-Stock Target F in 2010; Management Plan (MP) advice approach. Fcube estimates of effort by fleet corresponding to the individual “quota share” (or partial target F) by stock in 2010 when applying the five scenarios. Finfish species.

2010 Effort corresponding to single-stock quota share, nep stocks

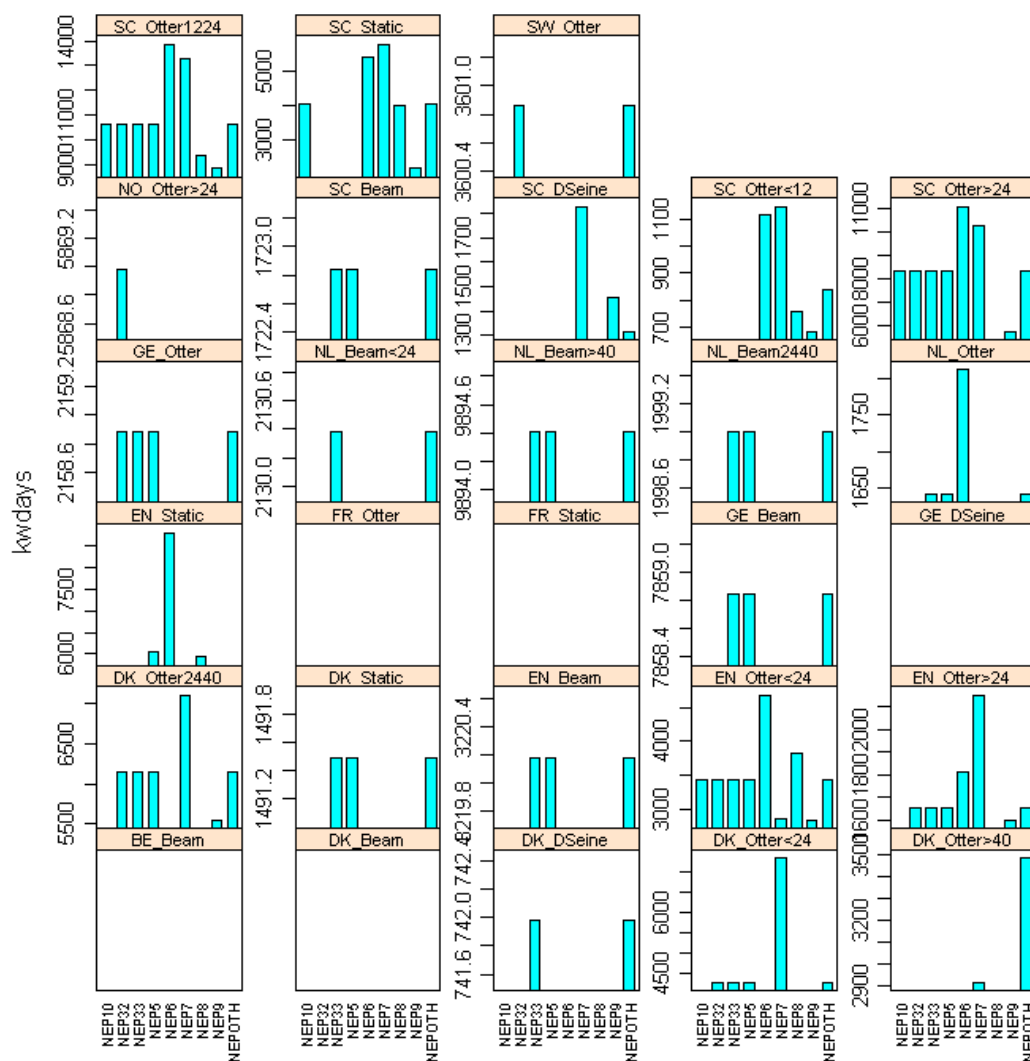


Figure 4.2.2.1.6. Intermediate year results. Single-Stock Target F in 2010; Management Plan (MP) advice approach. Fcube estimates of effort by fleet corresponding to the individual "quota share" (or partial target F) by stock in 2010 when applying the five scenarios. *Nephrops* FUs.

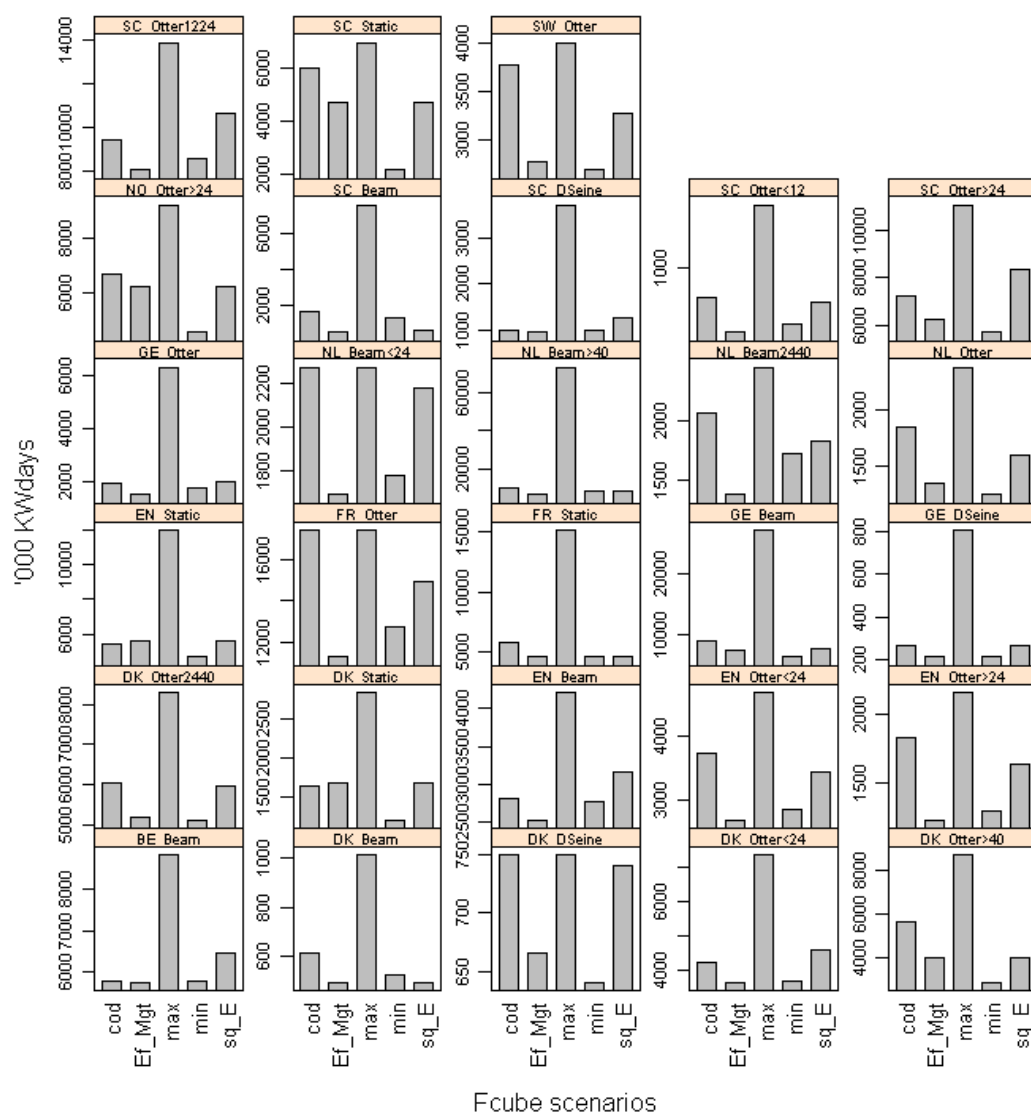


Figure 4.2.2.1.7. Intermediate year results. Management Plan (MP) advice approach. Fcube estimates of effort by fleet implied by the Fcube scenarios in the intermediate year (2010).

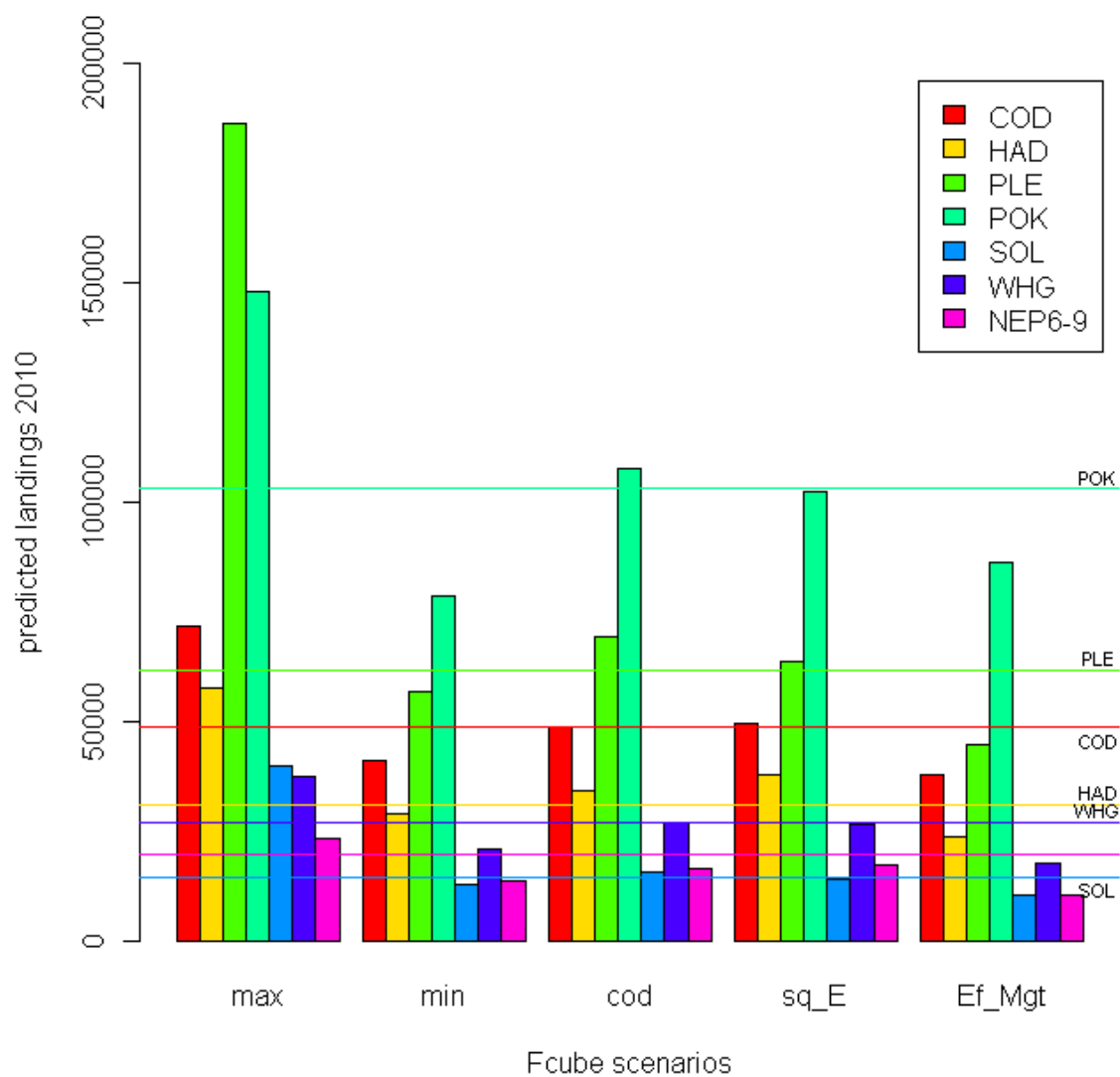


Figure 4.2.2.1.8. Intermediate year results. Management Plan (MP) advice approach. Fcube estimates of landings by stock for the Fcube scenarios in the intermediate year (2010). Coloured horizontal lines correspond to the intermediate year assumptions for catch from the single species stock assessments (as reproduced by the 'baseline run').

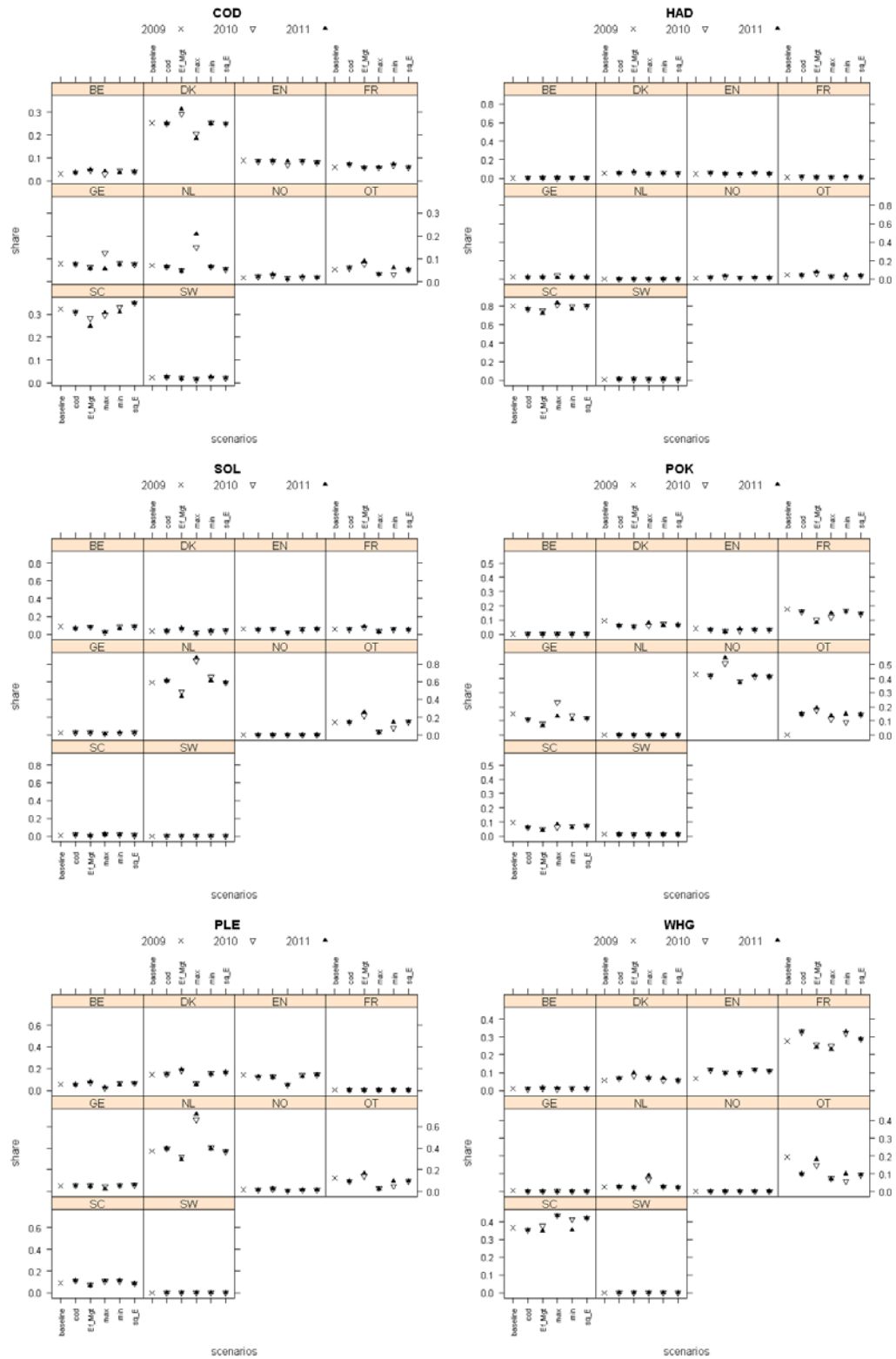


Figure 4.2.2.2.1: Test for relative stability. F_{MSY} advice approach. Changes of relative share of species' landings by country between 2010 and 2011 compared to the 2009 share, for the 5 Fcube scenarios.

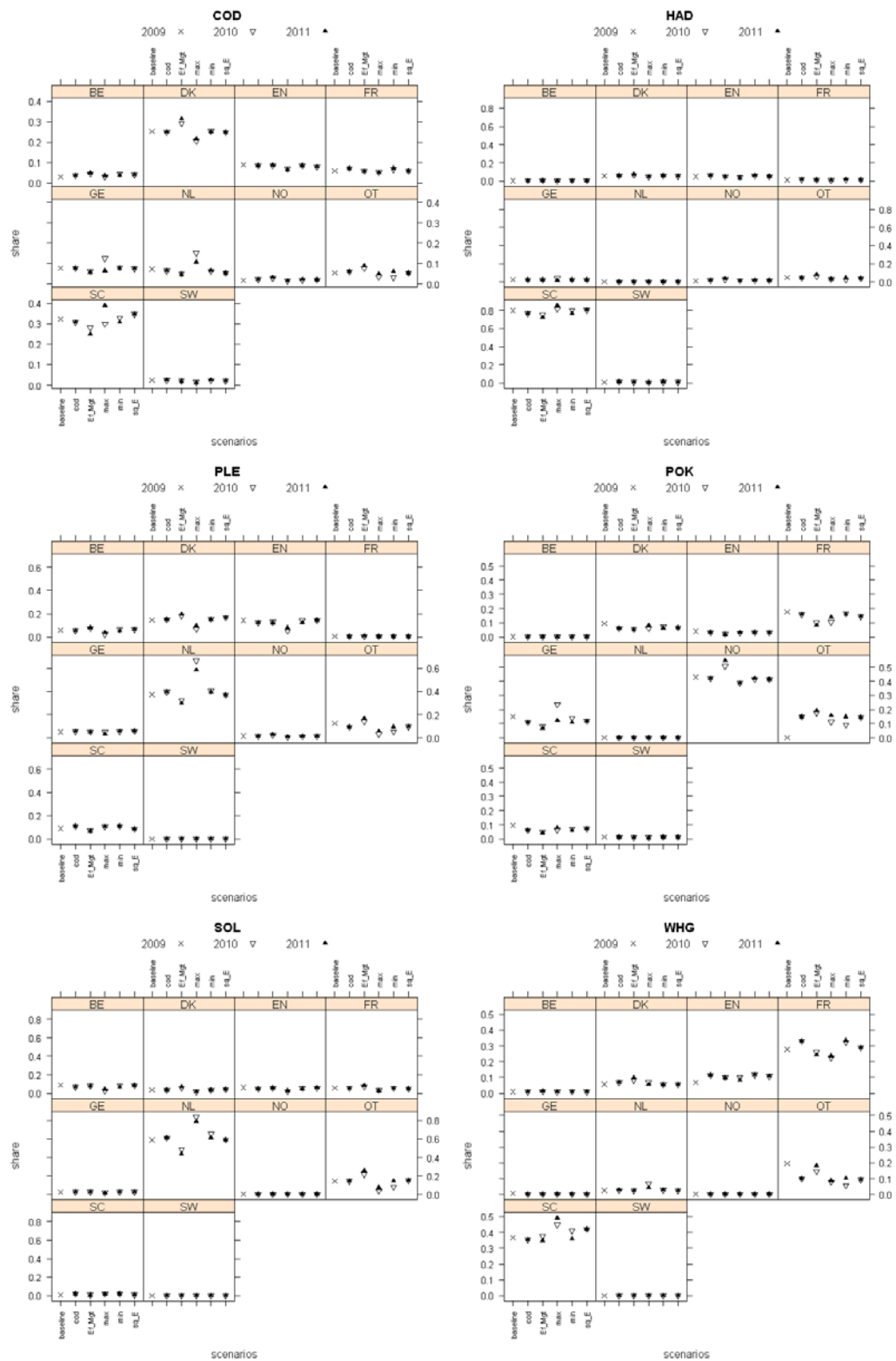


Figure 4.2.2.2.2: Test for relative stability. Management Plan (MP) advice approach. Changes of relative share of species' landings by country between 2010 and 2011 compared to the 2009 share, for the 5 Fcube scenarios.

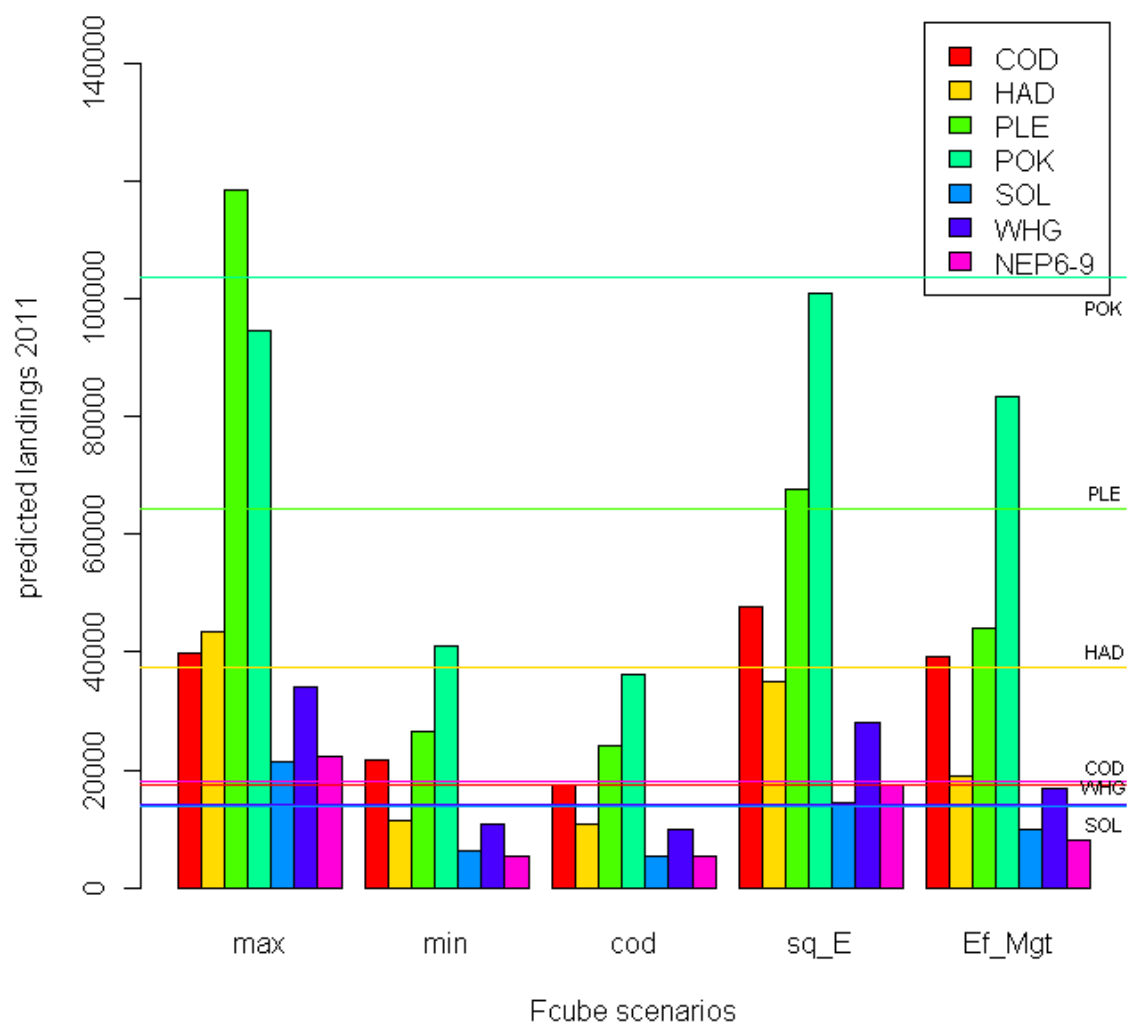


Figure 4.2.2.3.1. TAC year results. F_{MSY} advice approach. Fcube estimates of landings by stock after two successive years of applying the Fcube scenarios. Coloured horizontal lines correspond to the TAC set by the single species advice (as reproduced by the 'baseline run').

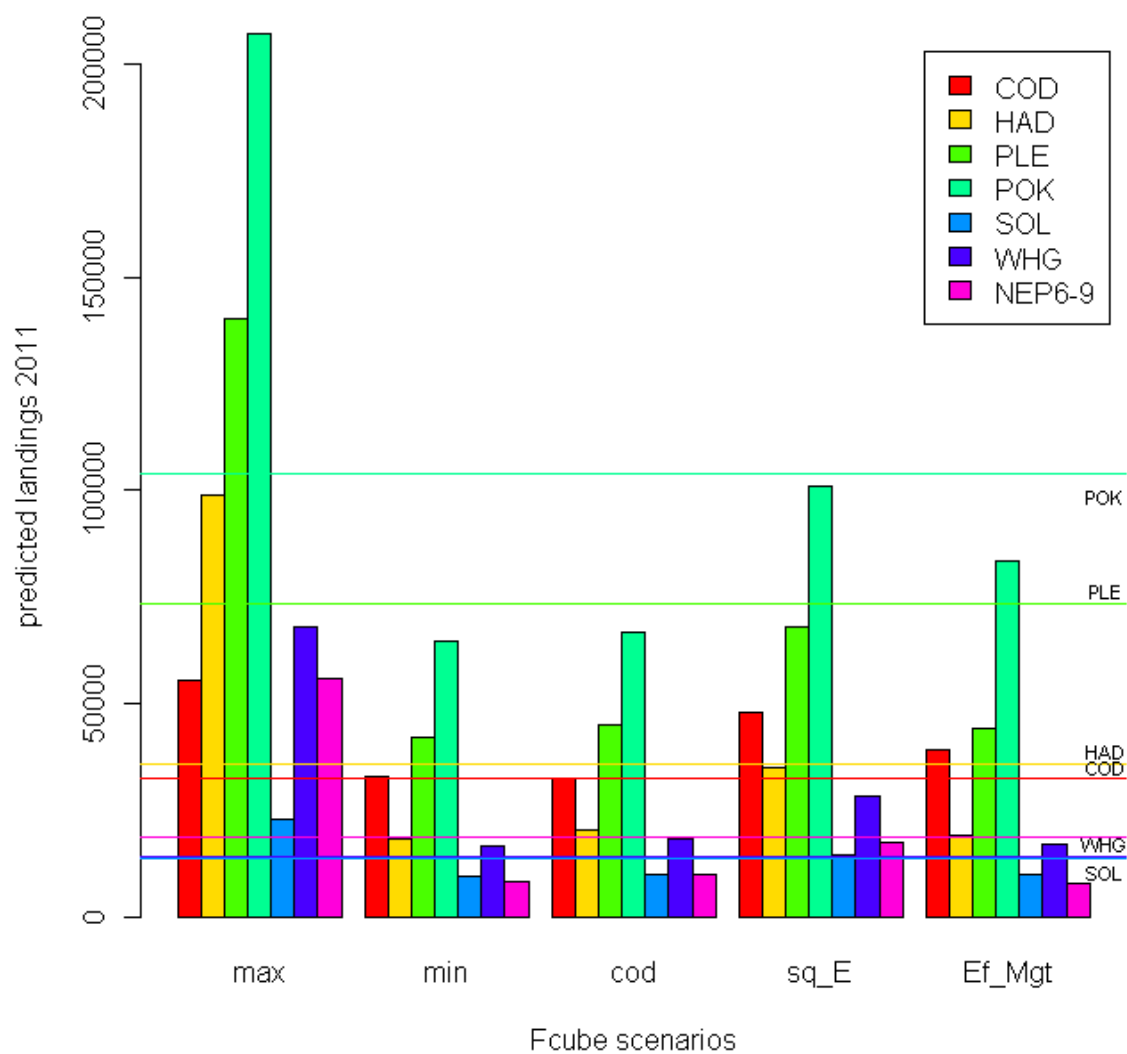


Figure 4.2.2.3.2. TAC year results. Management Plan (MP) advice approach. Fcube estimates of landings by stock after two successive years of applying the Fcube scenarios. Coloured horizontal lines correspond to the TAC set by the single species advice (as reproduced by the 'baseline run').

Annex 1: List of participants

Name	Address	Phone/Fax	Email
Steven Holmes (Chair)	Marine Scotland – Science Marine Laboratory P.O. Box 101 Aberdeen AB11 9DB United Kingdom	Phone +44(0) 1224 29 5507 Fax +44(0) 1224 29 5511	s.holmes@marlab.ac.uk
Clara Ulrich	Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua), Charlottenlund Slot Jægersborg Alle 1 DK-2920 Charlottenlund Denmark	Phone +45 35 88 33 95 Fax +45 35 88 38 33	clu@aqua.dtu.dk
Irene Huse	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 55 23 68 22 Fax +47 55 23 53 93	irene.huse@imr.no
Stuart Reeves	Centre for Environment, Fisheries and Aquaculture Science Lowestoft Laboratory; Pakefield Road NR33 0HT Lowestoft Suffolk United Kingdom	Phone +44 (0) 1502 52 4510 Fax +44 (0) 1502 52 7739	stuart.reeves@cefas.co.uk
Willy Vanhee	Institute for Agricultural and Fisheries Research Ankerstraat 1 B-8400 Oostende Belgium	Phone +32 5 956 9829 Fax +32 5 933 0629	willy.vanhee@ilvo.vlaanderen.be
Youen Vermard	IFREMER Boulogne-sur-Mer Centre P.O. Box 699 62321 Boulonge Cédex France	Phone +33 321 995 686 Fax +33 321 995 601	Youen.vermard@ifremer.fr

Annex 2: Specification of the ICES' data call

Format of data submission for ICES working Group on Mixed Fisheries Advice for the North Sea (WGMIXFISH):

Data reports can be provided in simple comma separated text files, Microsoft EXCEL or ACCESS formats. All missing values (empty data cells) must be indicated by a -1.

A. Mandatory Catch data detailed as given below and for 2003-2009 aggregated (sum) by ID. Please ensure that data entries are fully consistent with coding given in Appendixes.

- 1) ID (this is a unique identifier; e.g. the combination of country, year, quarter, vessel length, gear, mesh size range, and area; this is free text with a maximum of 40 characters without space)
- 2) COUNTRY (this should be given according to the code list provided in Appendix 1)
- 3) YEAR (this should be given in four digits), like 2004
- 4) QUARTER (this should be given as one digit), like 1, 2, 3, or 4
- 5) VESSEL_LENGTH (this should be given according to the code list provided in Appendix 2)
- 6) GEAR (gear should be given according to the code list provided in Appendix 3, which follows the EU data regulation 1639/2001)
- 7) MESH_SIZE_RANGE (the mesh size range should be given according to the code list provided in Appendix 4, which largely follows the Council regulation 850/98)
- 8) AREA (the ICES division or sub-area should be given according to the code list provided in Appendix 5)
- 9) SPECIES (the species should be given according to the code list provided in Appendix 6, which - except for the special case of Nephrops - follows the Council Regulation EC 2287/2003)
- 10) LANDINGS (estimated landings from domestic and foreign ports in metric tonnes should be given)
- 11) DISCARDS (estimated discards in metric tonnes associated with the landings should be given)
- 12) VALUE (total amount received – price*landings – at first sale, expressed in Euros).

Note: The specification of the VALUE field is an area where the specifications of this data call differ from that issued by DG Mare for consideration by STECF-SGMOS. This is to allow inclusion of a prediction scenario where market value influences quota uptake on different species by different metiers.

B. Mandatory effort data detailed as given below and for 2003-2009, aggregated (sum) by ID.

- 1) *ID (this is a unique identifier; e.g. the combination of country, year, quarter, gear, mesh size range, fishery or metier, and area; this is free text with a maximum of 40 characters without space)*
- 2) *COUNTRY (this should be given according to the code list provided in Appendix 1)*
- 3) *YEAR (this should be given in four digits)*
- 4) *QUARTER (this ID should be given as one digit)*
- 5) *VESSEL_LENGTH (This should be given according to the code list provided in Appendix 2)*
- 6) *GEAR (this identifies gear, and should be given according to the code list provided in Appendix 3, which follows largely the EU data regulation 1639/2001)*
- 7) *MESH_SIZE_RANGE (the mesh size range should be given according to the code list provided in Appendix 4, which follows largely the Council regulation 850/98).*
- 8) *AREA (the ICES division or sub-area should be given according to the code list provided in Appendix 5)*
- 9) *KW_DAYS Effort (effort should be given in kWdays, i.e. engine power in kW times days at sea; if kWdays effort is not available, "-1" should be given)*
- 10) *DAYS_AT_SEA Effort (effort should be given in days at sea; if Days_at_sea effort is not available "-1" should be given)*
- 11) *NO_VESSELS (simple integer value of the number of vessels, if the number is not available, "-1" should be given).*

Appendix 1 Country coding

COUNTRY	CODE
<i>Belgium</i>	<i>BEL</i>
<i>Denmark</i>	<i>DEN</i>
<i>Estonia</i>	<i>EST</i>
<i>Finland</i>	<i>FIN</i>
<i>France</i>	<i>FRA</i>
<i>Germany</i>	<i>GER</i>
<i>Ireland</i>	<i>IRL</i>
<i>Latvia</i>	<i>LAT</i>
<i>Lithuania</i>	<i>LIT</i>
<i>Netherlands</i>	<i>NED</i>
<i>Norway</i>	<i>NOR</i>
<i>Poland</i>	<i>POL</i>
<i>Portugal</i>	<i>POR</i>
<i>Spain</i>	<i>SPN</i>
<i>Sweden</i>	<i>SWE</i>
<i>United Kingdom (Jersey)</i>	<i>GBJ</i>
<i>United Kingdom (Guernsey)</i>	<i>GBG</i>
<i>United Kingdom (Alderny/Sark/Herm)</i>	<i>GBC</i>
<i>United Kingdom (England and Wales)</i>	<i>ENG</i>
<i>United Kingdom (Isle of Man)</i>	<i>IOM</i>
<i>United Kingdom (Northern Ireland)</i>	<i>NIR</i>
<i>United Kingdom (Scotland)</i>	<i>SCO</i>
<i>Other countries</i>	<i>OTH</i>

Appendix 2 Vessel Length

Note: This is an area where the specifications of this data call differ from that issued by DG Mare for consideration by STECF-SGMOS. This is to allow consistency in fleet definitions between landings, effort and economic data. Also, according to the Data Collection Framework, Member States should be able to provide data according to these segmentations (at least covering the year 2009 if not before)

<i>Vessel Length</i>	<i>Code</i>
<i>Under 12m</i>	<i>u12m</i>
<i>≥ 12m < 24m</i>	<i>o12t24m</i>
<i>≥ 24m < 40m</i>	<i>o24t40m</i>
<i>≥ 40m</i>	<i>o40m</i>

Appendix 3 Gear coding

TYPES OF FISHING TECHNIQUES			Gear code to be used when answering the data call	Gear code specified for métiers in App. IV of 2008/949/CE
Mobile gears	Beam trawls		BEAM	TBB
	Bottom trawls & demersal seines	Bottom otter trawls, Multi-rig otter trawls or Bottom pair trawls	OTTER	OTB, OTT, PTB
		Fly shooting seines, Anchored seines or Pair seines	DEM_SEINE	SSC, SDN, SPR
	Pelagic trawls & pelagic Seines	Midwater otter trawls or Midwater pair trawls	PEL_TRAWL	OTM, PTM
		Purse seines, Fly shooting seines or Anchored seines	PEL_SEINE	PS
	Dredges		DREDGE	DRB, HMD
Passive gears	Drifting longlines or Set longlines		LONGLINE	LHP, LHM, LTL, LLD, LLS
	Driftnets or Set gillnets (<i>except Trammel Nets</i>)		GILL	GNS, GND
	Trammel Nets		TRAMMEL	GTR
	Pots & traps		POTS	FPO

Appendix 4 Mesh size coding

Gear type	Code
Mobile gears	<16
	16-31
	32-54
	55-69
	70-79
	80-89
	90-99
	100-119
	>=120
Passive gears	10-30
	31-49
	50-59
	60-69
	70-79
	80-89
	90-99
	100-109
	110-149
	150-219
	>=220

Appendix 5 Area coding

Finfish

3an

4

7d

Appendix 6 Species coding according to Council Regulation (EC) No. 2298/2003

	<i>Common name</i>	<i>Code</i>	<i>Scientific name</i>
1	<i>Cod</i>	COD	<i>Gadus morhua</i>
2	<i>Common sole</i>	SOL	<i>Solea solea</i>
3	<i>Haddock</i>	HAD	<i>Melanogrammus aeglefinus</i>
4	<i>Plaice</i>	PLE	<i>Pleuronectes platessa</i>
5	<i>Saithe</i>	POK	<i>Pollachius virens</i>
6	<i>Whiting</i>	WHG	<i>Merlangius merlangus</i>

Note: The species coding for Nephrops is an area where the specifications of this data call differ from that issued by DG Mare for consideration by STECF-SGMOS. This is to allow calculation of catchabilities and mixed fishery predictions for functional units where abundance estimates are available.

<i>Common name</i>	<i>Functional Unit</i>	<i>Code</i>
Norway lobster	5	NEP5
Norway lobster	6	NEP6
Norway lobster	7	NEP7
Norway lobster	8	NEP8
Norway lobster	9	NEP9
Norway lobster	10	NEP10
Norway lobster	32	NEP32
Norway lobster	33	NEP33
Norway lobster	OTHER ICES RECTANGLES ¹	NEPOTH

¹ landings/discards from the other ICES' rectangles in the North Sea

Nephrops Functional Units and descriptions by statistical rectangle follow

Functional Unit	Stock	ICES Rectangles	Division
5	Botney Gut	36-37 F1-F4; 35F2-F3	IV
6	Farn Deep	38-40 E8-E9; 37E9	IV
7	Fladen	44-49 E9-F1; 45-46E8	IV
8	Firth of Forth	40-41E7; 41E6	IV
9	Moray Firth	44-45 E6-E7; 44E8	IV
10	Noup	47E6	IV
32	Norwegian Deep	44-52 F2-F6; 43F5-F7	IV
33	Off Horn Reef	39-41F4; 39-41F5	IV

Annex 3: Data issues for specific nations

Belgium

The Belgium landings and effort data were compiled according to the specification of the data request. Discard information was only available for the main metiers (Beam trawls) and since 2004.

Denmark

Landings and effort data were compiled according to the specification of the data request. It was only possible to attach discard information to some metiers.

France

The France data used for this Workshop and for the period before 2009 is the dataset submitted to the STECF effort review meeting. The vessel categories are less than 10 m, 10 m to 15 m and over 15 m.

Data for 2009 were not available for the meeting due to delays in the data processing.

Germany

Landings and effort data were compiled according to the specification of the data request. It was only possible to attach discard information to some metiers. The value information was not directly available, but some price information by main gear, vessel size and species were made available for 2009, and were applied as a proxy for value for the whole time series. Prices from trawl category were applied to the gear categories without price information.

The Netherlands

The Dutch data used for this workshop were not those submitted to STECF, but were provided directly by IMARES. No discards data were included in the data set, but discards estimates for the large Dutch Beam trawlers were provided independently and added to the data. No value information was available.

Norway

The Norwegian data used for this workshop were provided directly by IMR, without discards estimates.

UK (England, Wales and Northern Ireland)

Data were provided for England, Wales and Northern Ireland for the period 2003-2009 according to the data call. Discard data were applied where available. Not all length classes of vessels are routinely sampled for discards, but the discard data were applied to all vessel length categories irrespective of this. The dataset includes some vessels from UK (Northern Ireland) and from Guernsey that fish in the North Sea and/or Eastern Channel. These vessels are lumped in with the English fleet for analysis.

Scotland

Landings and effort data were compiled according to the specification of the data request. It was only possible to attach discard information to some metiers; also the stratification of the Scottish discard observer scheme changed in 2009. For data between 2003 and 2008 the Scottish discard observer scheme was designed to achieve a reasonable coverage of vessels in each of the following categories

- MTR: Motor trawl (bottom trawls, boat length $\geq 27.432\text{m}$, targeting demersal species)
- LTR: Light trawl (bottom trawls, boat length $< 27.432\text{m}$, targeting demersal species)
- PTR: Pair trawl (all pair trawls targeting demersal species)
- SEN: Seine nets (single and pair)
- NTR: *Nephrops* trawls (all trawls targeting *Nephrops*)

Where the gear categories for records in the landings dataset could be mapped to one of the above categories a discard value was assigned according to the discard ratio of that category. Therefore records mapped to these categories always receive the same ratio of discards to landings.

Vessels with OTTER and PEL_TRAWL gear and in the length categories o24t40m and o40m were mapped to the MTR category. However, as for STECF effort calculations all records with OTTER gear and with mesh between 70 and 100mm are mapped to NTR.

In 2009 discard fractions were available for the two categories

- ☐ DEF: Demersal otter, demersal seine and beam trawls targeting demersal fish
- ☐ CRU: Demersal otter, demersal seine and beam trawls targeting crustaceans

Vessels with PEL_TRAWL gear and with OTTER gear with mesh $> 100\text{mm}$ were mapped to the DEF category. Vessels with OTTER gear with mesh $< 100\text{mm}$ were mapped to the CRU category. The Scottish fleet consists of few beam trawlers and the discard rates in the DEF and CRU categories reflect those from otter and demersal seine gears. Discards were therefore not attached to beam trawl landings.

The sampling of vessels $< 10\text{m}$ is very limited and it is considered unreasonable to assume they have the same discarding patterns as larger boats. Scotland does not provide discard estimates for vessels $< 10\text{m}$ to STECF. Discard estimates are therefore not estimated for vessels in the u12m category.

Annex 4: North Sea Mixed Fisheries Advice

Mixed fisheries advice

Area	North Sea
Fisheries	Demersal

Mixed fisheries advice is dependent upon the choice of species considered and the criteria selected. In contrast to single species advice there is no single recommendation but a range of plausible options. ICES single species advice provides TACs expected to keep a species above a biomass level regarded as safe for the stock, or to return a species to a safe biomass level within a precautionary timeframe. To be consistent with these biological objectives a scenario is necessary that delivers the SSB and/or F objectives of the single species stock advice for all stocks considered simultaneously. This document presents five scenarios out of which the *minimum* scenario guarantees this outcome. However, this scenario assumes that fleets would stop fishing when their first quota share is exhausted, regardless of the actual importance of this quota share, thus leading to a distorted perception of plausible fleet behaviour. It is included only to demonstrate the lower bound of potential fleet effort and stock catches.

In addition to the minimum scenario a maximum scenario is included. This is included to demonstrate the upper bound of potential fleet effort and stock catches but, through assuming all fleets continue fishing until all their quotas are exhausted irrespective of the economic viability of such actions, is also considered a scenario with low plausibility. Currently three other scenarios are included, reflecting basic current management measures and also the status quo option.

Scenario Descriptions

	Underlying assumption
min	Minimum scenario: fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary.
max	Maximum scenario: fishing stops when the last quota species is fully utilised with respect to the upper limit corresponding to single stock exploitation boundary.
cod	All fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks
sq_E	Status quo Effort: The effort is set as equal to the effort in the most recently recorded year for which there is landings and discard data.
Ef_Mgt	Effort management: The effort in métiers using gear controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulations (EC) No 1342/2008 and No 23/2010).

ICES is willing to consider further options that may be suggested by ICES' clients.

Species involved

The species considered here as part of the demersal mixed fisheries of the North Sea are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. All of these are now subject to multi-annual management plans apart from whiting (jointly managed between EU and Norway) and *Nephrops* (separately managed).

Species	ICES single stock advice area	Mgt area	Mgt plan ref(s)
Cod	Subarea IV, Division VIIId and IIIa West (Skagerrak)	<ul style="list-style-type: none"> • EU TAC Skagerrak • EU TAC VIIId • IV; EC waters of IIa; that part of IIIa not covered by the Skagerrak and Kattegat 	<ul style="list-style-type: none"> • EU and Norway management plan • Council Reg (EC) 1342/2008
Haddock	Haddock in Subarea IV and Division IIIa West (Skagerrak)	<ul style="list-style-type: none"> • EU TAC IIIa, EC waters of IIIb, IIIc and IIId • IV; EC waters of IIa 	<ul style="list-style-type: none"> • EU and Norway management plan
Whiting	IV and VIIId (MF advice includes human consumption and industrial landings)	<ul style="list-style-type: none"> • IV • EU TAC VII 	<ul style="list-style-type: none"> • na
Saithe	Subarea IV, Division IIIa West (Skagerrak) and Subarea VI	<ul style="list-style-type: none"> • IIIa and IV; EC waters of IIa, IIb, IIc and IIId • VI; EC waters of Vb; EC and international waters of XII and XIV 	<ul style="list-style-type: none"> • EU and Norway management plan
Plaice	Sub-area IV	<ul style="list-style-type: none"> • IV; EC waters of IIa; that part of IIIa not covered by the Skagerrak and the Kattegat 	<ul style="list-style-type: none"> • Council Reg (EC) No 676/2007
Sole	Sub-area IV	<ul style="list-style-type: none"> • EC waters of II and IV 	<ul style="list-style-type: none"> • Council Reg (EC) No 676/2007
<i>Nephrops</i>	Functional Units: 5, 6, 7, 8, 9, 10, 32, 33, other areas outside FUs	<ul style="list-style-type: none"> • EU: TAC for IV • Norway: no TAC 	<ul style="list-style-type: none"> • na

Management objectives and Advice Approaches

Rather than giving one specific advised catch for 2011 for each stock, The 2010 ICES advice for the North Sea demersal stocks includes catch options consistent with the transition to an MSY approach, with existing management plans and with the precautionary approach. Reflecting this, mixed fishery projections were run for both F_{MSY} and management plan advice approaches. Precautionary approach advice was included when F_{MSY} advice was unavailable. In the cases of whiting and *Nephrops* F_{MSY} and management plan advice is not available. For *Nephrops* ICES precautionary advice is substituted for F_{MSY} advice and for the management plan advice approach TAC setting along the lines of the Policy document presented by the EU policy paper

COM(2010) 241 is adopted. For whiting the ICES advice to maintain SSB unchanged in 2012 compared to 2010 is adopted for both advice approaches, (see Table 3.1.1 of ICES 2010).

Projected TACs

The results under the scenarios in table XXa and XXb give the expected outcome if TAC and effort management measures specified under single species advice remain unchanged and

- 'Fcube interm YR and MP in TAC YR': the assumptions of each scenario hold true in the intermediate year but the rules of the advice approach are applied and adhered to in the TAC year. In this case the comparison to the single stock exploitation boundary for a given species gives an indication of the robustness of the advice approach (i.e. the TAC specified) to assumptions about catches in the intermediate year.
- 'Fcube interm YR and Fcube in TAC YR': the assumptions of each scenario hold true in both the intermediate year and TAC year. In this case, if the scenario total is lower than the single stock exploitation boundary for a given species the difference is an estimate of unused TAC. If the scenario total is higher than the single stock exploitation boundary for a given species the difference is an estimate of overall discards of that species.

Projected SSBs in 2012

Catches predicted to be above the single stock exploitation boundary can be for two reasons

- The scenario predicts over-exploitation in both the intermediate and TAC year, in which case the biomass of the stock at the end of the TAC year will be reduced compared to if catches remained at the single stock exploitation boundary.
- The scenario predicts under-exploitation in the intermediate year leading to an enhanced SSB at the end of the intermediate year. The single species HCR for the TAC year may then be fulfilled even if catches are higher than the single stock exploitation boundary for the TAC year.

The catch predictions for each species must therefore be considered in combination with the predicted SSB at the end of the TAC year. The results under the scenarios in table YYa and YYb give the expected SSBs in 2012. Again, for each scenario, a contrast is made between

- Assuming the scenario holds true in the intermediate year but the single species advice is applied and upheld in the TAC year.
- Assuming the scenario holds true in both the intermediate year and TAC year.

Table XXa: Estimated catches in 2011 ('000 t). Result of applying the assumptions of max and min scenarios.

Species	Single stock expl. boundaries		Scenario A, mixed fisheries				Scenario B, mixed fisheries			
			MIN				MAX			
			F _{MSY}		MP		F _{MSY}		MP	
			Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR
	F _{MSY}	MP								
COD	17500	32300	21600	21600	32800	32700	11300	39900	32300	55300
HAD	37400	35800	37900	11500	37900	18300	32000	43600	32500	99000
PLE	64300	73400	65300	26600	73400	42100	32900	118000	54200	140000
POK	104000	104000	111000	41200	111000	64500	88800	94800	100000	207000
SOL	13900	13600	14500	6100	12300	9500	6000	21300	16200	22800
WHG	14200	14200	22500	10800	22500	16700	9200	34100	10100	68100
NEP10	-	140	NaN	30	140	40	NaN	110	140	270
NEP32	640	1200	640	140	1200	210	640	590	1200	1400
NEP33	1200	1300	1200	340	1300	520	1200	1400	1300	3500
NEP5	980	1100	980	210	1100	320	980	880	1100	2200
NEP6	1600	1600	1600	660	1600	1100	1600	2600	1600	6200
NEP7	13300	13300	13300	3200	13300	5200	13300	13700	13300	34800
NEP8	2000	2400	2000	940	2400	1400	2000	4100	2400	10100
NEP9	1300	1300	1300	430	1300	640	1300	1800	1300	4900
NEPOTH	1900	2000	1900	720	2000	1100	1900	3000	2000	7500

Table XXb: Estimated catches in 2011. Result of applying the assumptions of the scenarios.

Species	Single stock expl. boundaries		Scenario C, mixed fisheries Status Quo Effort				Scenario D, mixed fisheries Cod Management Plan				Scenario E, mixed fisheries Effort Management			
			FMSY		MP		FMSY		MP		FMSY		MP	
	FMSY	MP	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR
COD	17500	32300	18800	47800	32300	47800	17500	17500	32300	32300	22700	39100	34400	39100
HAD	37400	35800	36000	35100	36000	35100	35800	10900	36800	20100	39000	18900	39000	18900
PLE	64300	73400	63300	67800	73400	67800	59300	24100	73400	45100	68600	44000	73400	44000
POK	104000	104000	104000	101000	104000	101000	98100	36200	102000	66700	109000	83600	109000	83600
SOL	13900	13600	14000	14500	13300	14500	12900	5500	14200	10000	15300	9900	12000	9900
WHG	14200	14200	19200	28100	19200	28100	15900	9900	18800	18100	21800	16900	21800	16900
NEP10	NaN	140	NaN	90	140	80	NaN	30	140	50	NaN	40	140	40
NEP32	640	1200	640	460	1200	440	640	140	1200	250	640	210	1200	200
NEP33	1200	1300	1200	1100	1300	1100	1200	340	1300	610	1200	510	1300	500
NEP5	980	1100	980	690	1100	670	980	210	1100	380	980	320	1100	310
NEP6	1600	1600	1600	2000	1600	2000	1600	660	1600	1200	1600	920	1600	920
NEP7	13300	13300	13300	11000	13300	11000	13300	3200	13300	5900	13300	4700	13300	4700
NEP8	2000	2400	2000	2900	2400	2900	2000	960	2400	1800	2000	1500	2400	1500
NEP9	1300	1300	1300	1400	1300	1400	1300	440	1300	810	1300	740	1300	740
NEPOTH	1900	2000	1900	2400	2000	2300	1900	720	2000	1300	1900	1100	2000	1100

Table YYa: SSB in 2012 as a result of applying the assumptions of max and min scenarios.

Species	Single stock expl. boundaries		Scenario A, mixed fisheries				Scenario B, mixed fisheries			
			MIN				MAX			
			FMSY		MP		FMSY		MP	
	FMSY	MP	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR
COD	75100	67600	93200	93200	80800	80800	48100	18300	26400	4800
HAD	211000	213000	213000	247000	213000	238000	185000	170000	185000	100000
PLE	532000	518000	543000	606000	530000	580000	321000	185000	286000	154000
POK	219000	219000	237000	301000	237000	280000	185000	180000	177000	90800
SOL	36600	36900	37800	45700	39800	42500	20100	6400	10800	5200
WHG	180000	180000	182000	191000	182000	183000	180000	142000	180000	100000

Table YYb: SSB in 2012 as a result of applying the assumptions of the Status Quo Effort, Cod Management Plan and Effort Management plan scenarios.

Species	Single stock expl. boundaries		Scenario C, mixed fisheries				Scenario D, mixed fisheries				Scenario E, mixed fisheries			
			Status Quo Effort				Cod Management Plan				Effort Management			
			FMSY		MP		FMSY		MP		FMSY		MP	
	FMSY	MP	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR	Fcube interm YR and MP in TAC YR	Fcube interm YR and Fcube in TAC YR
COD	75100	67600	81000	49300	66100	49300	75100	75100	67600	67600	98100	79700	84900	79700
HAD	211000	213000	204000	206000	204000	206000	203000	236000	208000	229000	218000	244000	218000	244000
PLE	532000	518000	530000	522000	513000	522000	503000	560000	500000	546000	565000	605000	557000	605000
POK	219000	219000	220000	222000	220000	222000	207000	262000	216000	248000	232000	255000	232000	255000
SOL	36600	36900	36900	36500	37600	36500	34700	41700	35200	39200	39400	44400	42500	44400
WHG	180000	180000	180000	163000	180000	163000	180000	182000	180000	175000	186000	187000	186000	187000

Management considerations

Effort management

The Effort management scenario applies the effort changes on relevant gear types stated in the latest effort management legislation (Council Regulation (EC) 23/2010) for the intermediate year. The exception were the small effort cuts applied to static gears (see Table AA2) because fleets operating these gears were merged into the 'OTH' fleet because of small catch volumes. The effort reductions are applied to all fleets equally regardless of whether the fleets have had their kWdays effort pot reduced or whether they are subject to a scheme intended to reduce fishing mortality on cod to the same extent as the effort cuts.

Environment

The relative impact on the wider environment (i.e. outside the effect on the SSB of the species included in the projections) of the different scenarios is currently outside the scope of this advice.

Economics

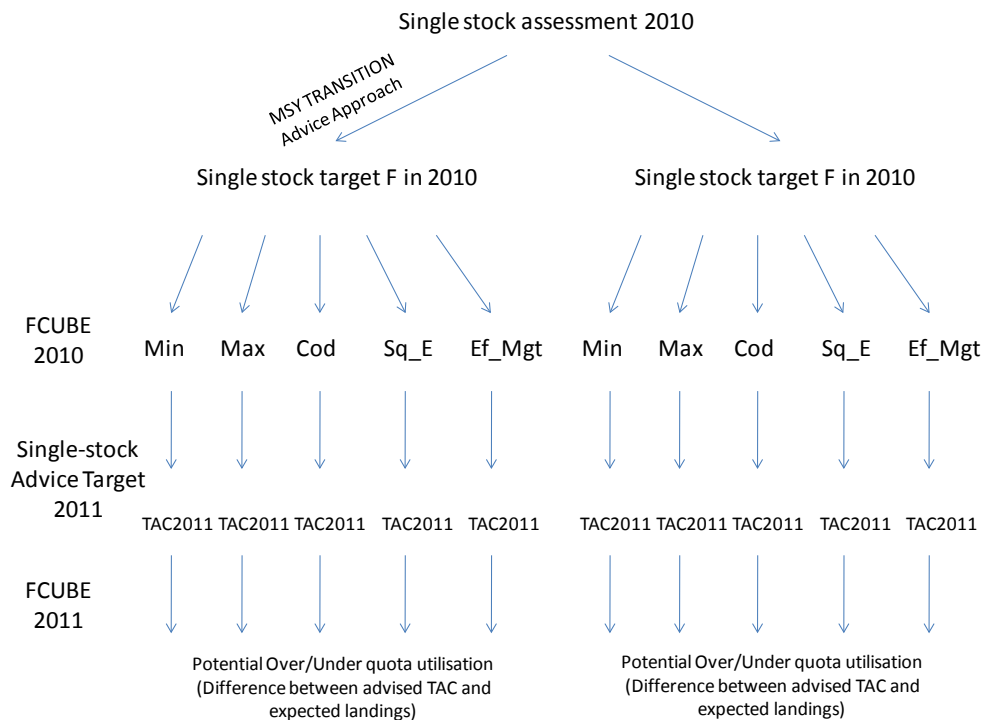
Economic data have not been taken into consideration in the current projections.

ANNEX

Technical information

The mixed fisheries Fcube model was developed in order to be able to predict the effect of, and to advise on, TAC and effort management of stocks in mixed fisheries circumstances. The North Sea demersal fisheries have been used as a starting point for this modelling.

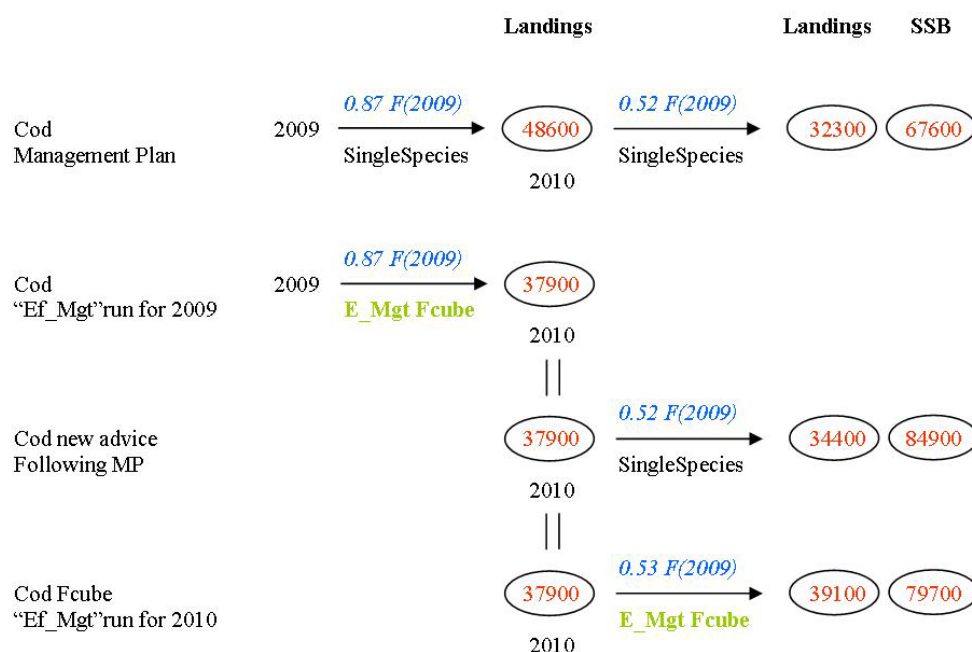
The model takes into account the effort and catches of separate metiers and predicts catches on the basis of different scenarios with effort and catch limitations.



Assumptions in Fcube

- i) Stock-metier catchability is determined according to
 - A) Average over last three years if a linear fit to log catchabilities demonstrates no significant trend (5% confidence limit)
 - B) Catchability from most recent year if a linear fit to log catchabilities demonstrates no significant trend (5% confidence limit)
- ii) Fleet effort share by metier is the same as averaged over a determined number of years (most recent three years). It does not change within the management year as a result of restrictions except in the **Ef_Mgt** scenario. In the **Ef_Mgt** scenario, for appropriate metiers effort is changed by the same amount as in the effort ceilings for metiers imposed for the intermediate year by the Commission.
- iii) Discards are allocated to fleets based on available data
- iv) Relative stability (of quota) and average landing shares

The following flow diagram and text is aimed to aid the interpretation of tables XXb and YYb. The example follows the landings results for the cod stock in the Fcube Ef_Mgt scenario under the MP advice approach :



Green color - Bold: This option is the Fcube run

Blue color - Italic: Fishing mortality factor relative to F2009

Red numbers in ○ : Resulting TAC or catch from table 4.2.2.3.2

In this example, the baseline run, which follows the single-stock ICES advice, assumes landings of 48600 tonnes in 2010 (corresponding to a 13% reduction in F from F2009 to F2010 following the Management Plan), and 32300 tonnes in 2011 applying a 20% TAC reduction from the 2010 TAC (2nd column Table XXb). The resulting SSB in 2012 is estimate to be 67600 tonnes (2nd column Table YYb). However, assuming that the effort restrictions imposed for 2010 on TR1, TR2 and BT2 (25% reduction) are applied, then the 2010 landings are estimated at 37900 tonnes, i.e. 22% less than assumed in the baseline. If this was the case, then the TAC advice for 2011 could be set to 34400 tonnes in order to comply with the single species advice in 2011 (13th column Table XXb), i.e. an increase of 7% compared to the single-species advice. The resulting SSB in 2012 is estimated to be 84900 tonnes (13th column Table YYb), 26% higher than the resulting SSB following the single species advice according to the cod Management Plan.

If again we assumed that the fleets would fish in line with the effort reductions in 2011 (10% reduction for TR1, TR2 and BT2), then the landings in 2011 would be estimated at 39100 tonnes (14th column Table XXb), i.e. 21% above the initial single-stock baseline and 14% above the landings corresponding to the Management Plan. While the Single-Stock advice estimates a SSB level around 67600 tonnes by 2012 under full compliance with the MP, the **Ef_Mgt** Fcube scenario (following the effort reduction from the Management Plan) estimates SSB in 2012 as high as 79700 tonnes (14th column Table YYb).

Baseline for the prediction

Table AA1: Baseline values used in the Mixed fisheries projections

	FMSY				Management Plan		
	Landings in intermediate year ('000 t)	F multiplier	SSB ('000 t)		Landings in intermediate year ('000 t)	F multiplier	SSB ('000 t)
COD	53.4	1.0	54.8		48.6	0.87	54.8
HAD	31.1	1.0	196.0		31.1	1.0	196.0
PLE	61.8	1.0	435.0		61.8	1.0	435.0
POK	103.0	1.0	233.0		103.0	1.0	233.0
SOL	14.6	1.0	32.9		14.6	1.0	32.9
WHG	26.8	1.0	180.0		26.8	1.0	180.0
NEP5	0.72				0.72		
NEP6	2.7	1.0			2.7	1.0	
NEP7	13.3	1.0			13.3	1.0	
NEP8	2.7	1.0			2.7	1.0	
NEP9	1.1				1.1	1.0	
NEP10	0.90				0.9		
NEP32	0.48				0.48		
NEP33	1.2				1.2		
NEPOTH	2.5				2.5		

Table AA2: Effort reductions in 2010 compared to 2009 by EU regulated fleet segment.

Gear Description	Code	% effort reduction
Bottom trawls and seines $\geq 100\text{mm}$	TR1	25%
Bottom trawls and seines $\geq 70\text{mm}$ & $< 100\text{mm}$	TR2	25%
Bottom trawls and seines $\geq 16\text{mm}$ & $< 32\text{mm}$	TR3	0%
Beam trawls $\geq 120\text{mm}$	BT1	0%
Beam trawls $\geq 80\text{mm}$ & $< 120\text{mm}$	BT2	25%
Gill nets and entangling nets, excluding trammel nets	GN1	0%
Trammel nets	TN1	Between 0% and 9,92% for some countries
Longlines	LL1	0%
Not regulated gear	None	0%

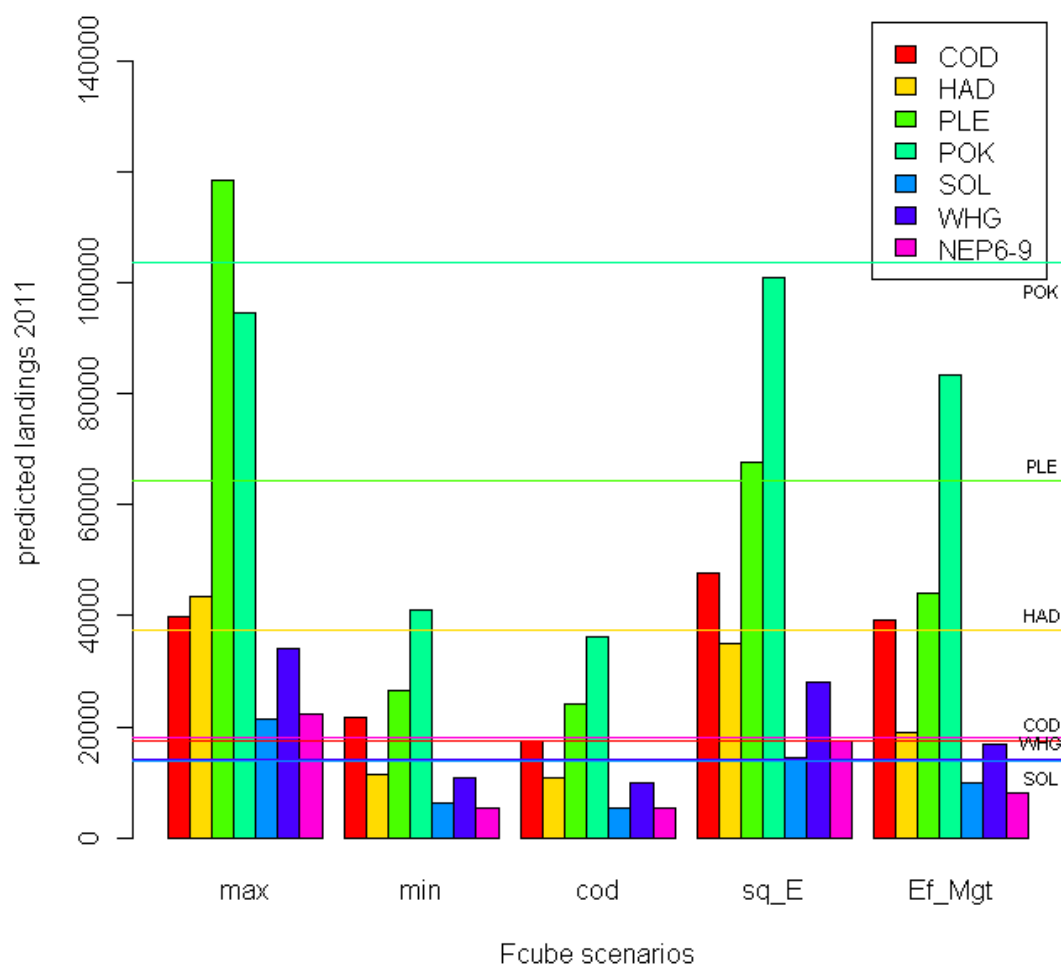


Figure #1. TAC year results. FMSY advice approach. Fcube estimates of landings by stock after two successive years of applying the Fcube scenarios. Coloured horizontal lines correspond to the TAC set by the single species advice (as reproduced by the 'baseline run').

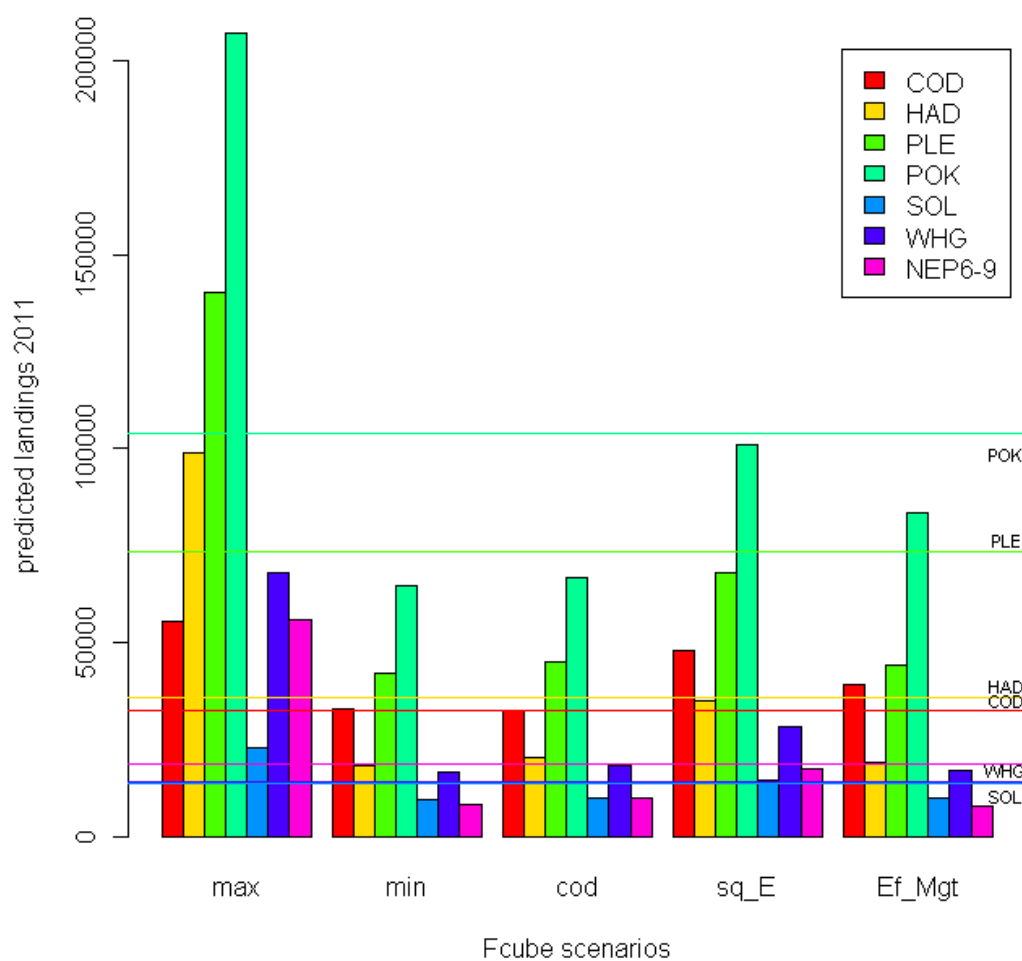


Figure #2. TAC year results. Management Plan (MP) advice approach. Fcube estimates of landings by stock after two successive years of applying the Fcube scenarios. Coloured horizontal lines correspond to the TAC set by the single species advice (as reproduced by the 'baseline run').

References

ICES, 2010. Report of the Working Group on Mixed Fisheries Advice for the North Sea (WGMIXFISH), 31 August - 3 September 2010. ICES CM 2010/ACOM:35.

Annex 5: North Sea Mixed Fisheries Annex

Mixed Fisheries Annex

Regional specific documentation of standard assessment procedures used by ICES.

Eco-Region North Sea

Date: September 2010

Revised by WGMIXFISH

A. General

A.1. Area definition

This mixed fisheries advice will consider finfish species in the ICES area IV, IIa, IIIa, VI and VIIId and for *Nephrops norvegicus* in functional units FU5, FU6, FU7, FU8, FU9, FU10, FU32, FU33 and ICES' rectangles outside of these eight functional units – denoted FUOTHER.

The species considered are part of the demersal mixed fisheries of the North Sea, and are cod, haddock, whiting, saithe, plaice, sole and *Nephrops norvegicus*. There are eight *Nephrops* functional units in the North Sea, which are considered as separated stocks. However, only four of these can be assessed through fishery-independent abundance estimates from underwater video surveys, and these were kept as distinct stocks. These cover the stocks along the English and Scottish coast; i.e. FU 6 (Farn Deep), FU 7 (Fladen Ground), FU 8 (Firth of Forth) and FU 9 (Moray Firth). The four other functional units (FU 5, FU 10, FU 32 and FU 33) have no independent abundance estimates.

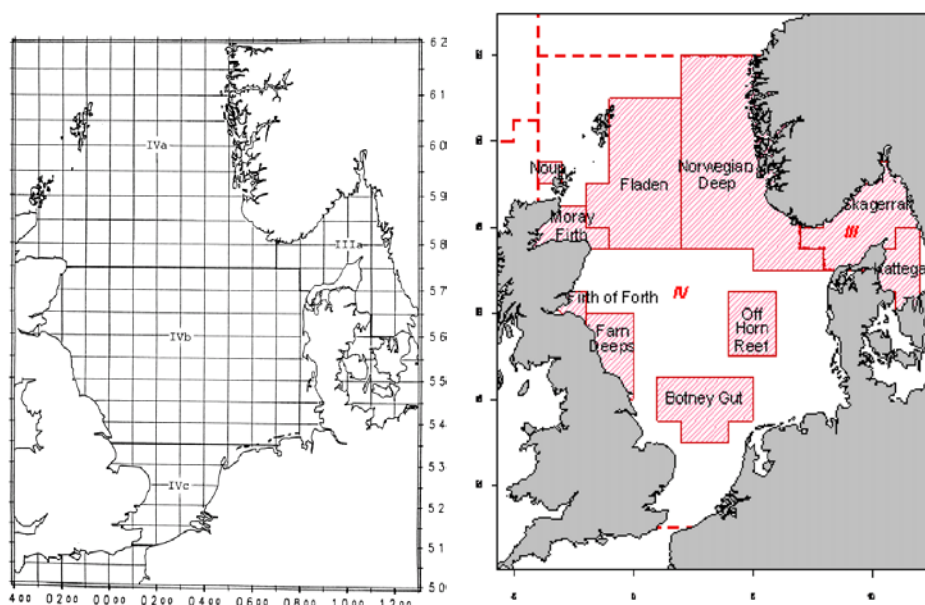


Figure xx.1 Area description for finfish advice and *Nephrops* Functional Units (FU) in the North Sea and Skagerrak/Kattegat region.

Table XX.1 *Nephrops* Functional Units (FU) in the North Sea.

FU no.	Name	ICES area	Statistical rectangles
5	Botney Gut - Silver Pit	IVb,c	36-37 F1-F4; 35F2-F3
6	Farn Deep	IVb	38-40 E8-E9; 37E9
7	Fladen Ground	IVa	44-49 E9-F1; 45-46E8
8	Firth of Forth	IVb	40-41E7; 41E6
9	Moray Firth	IVa	44-45 E6-E7; 44E8
10	Noup	IVa	47E6
32	Norwegian Deep	IVa	44-52 F2-F6; 43F5-F7
33	Off Horn Reef	IVb	39-41E4; 39-41F5

Finfish stocks

Species	ICES single stock advice area
Cod	Subarea IV, Division VIIId and IIIa West (Skagerrak)
Haddock	Subarea IV (North Sea) and Division IIIa West (Skagerrak)
Whiting	IV and VIIId
Saithe	Subarea IV, Division IIIa West (Skagerrak) and Subarea VI
Plaice	Sub-area IV
Sole	Sub-area IV

Herring, mackerel and the industrial fisheries (sandeel, Norway pout and sprat) are not considered in a mixed fisheries advice context given the targeted nature of their fleets.

A.2. Fishery

Cod in IIIa - IV - VIIId

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species. In some of them cod are considered to be a by-catch (for example in beam trawls targeting flatfish), and in others the fisheries are directed mainly towards cod (for example, some of the fixed gear fisheries). An analysis of landings and estimated discards of cod by gear category (excluding Norwegian data) highlighted the following fleets as the most important in terms of cod for 2003-5 (accounting for close to 88% of the EU landings), listed with the main use of each gear (STECF SGRST-07-01):

- Otter trawl, ≥ 120 mm, a directed roundfish fishery by UK, Danish and German vessels.
- Otter trawl, 70-89mm, comprising a 70-79mm French whiting trawl fishery centered in the Eastern Channel, but extending into the North Sea, and an 80-89mm UK *Nephrops* fishery (with smaller landings of roundfish and angler-fish) occurring entirely in the North Sea.
- Otter trawl, 90-99mm, a Danish and Swedish mixed demersal fishery centered in the Skagerrak, but extending into the Eastern North Sea.
- Beam trawl, 80-89mm, a directed Dutch and Belgian flatfish fishery.
- Gillnets, 110-219mm, a targeted cod and plaice fishery.

For Norway in 2007, trawls (mainly bycatch in the saithe fishery) and gillnets account for around 60% (by weight) of cod catches, with the remainder taken by other gears mainly in the fjords and on the coast, whereas in the Skagerrak, trawls and gillnets account for up to 90% of cod catches. The minimum catching size of cod for Norwegian vessels was increased to 40 cm in 2008.

ICES in 2009 (WGFTFB) has noted a change in effort from far sea fishing grounds in mixed fisheries due to increased fuel costs from 2008 to 2009. There is most probably a significant change in fishing pattern from area IV to Porcupine, Rockall and Celtic Sea.

With regard to trends in effort for these major cod fisheries since 2000, the largest changes in North Sea fisheries have involved an overall reduction in trawl effort and changes in the mesh sizes in use, due to a combination of decommissioning and days-at-sea regulations. In particular 100-119 mm meshes have now virtually disappeared, and instead vessels are using either 120 mm+ (in the directed whitefish fishery) or 80-99 mm (primarily in the *Nephrops* fisheries and in a variety of mixed fisheries). The use of other mesh sizes largely occurs in the adjacent areas, with the 70-79 mm gear being used in the Eastern Channel/Southern North Sea Whiting fishery, and the majority of the landings by 90-99 mm trawlers coming from the Skagerrak. Higher discards are associated with these smaller mesh trawl fisheries, but even when these are taken into account, the directed roundfish fishery (trawls with ≥ 120 mm mesh) still has the largest impact of any single fleet on the cod stock, followed by the mixed demersal fishery (90-99 mm trawls) in the Skagerrak.

Apart from the technical measures set by the Commission, additional unilateral measures are in force in the UK, Denmark and Belgium. The EU minimum landing size (mls) is 35 cm, but Belgium operates a 40 cm mls, while Denmark operate a 35 cm mls in the North Sea and 30 cm in the Skagerrak. Additional measures in the UK relate to the use of square mesh panels and multiple rigs, restrictions on twine size in both whitefish and *Nephrops* gears, limits on extension length for whitefish gear, and a ban on lifting bags. In 2001, vessels fishing in the Norwegian sector of the North Sea had to comply with Norwegian regulations setting the minimum mesh size at 120 mm. Since 2003, the basic minimum mesh size for towed gears targeting cod is 120 mm.

Haddock in IIIa – IV

The largest proportion of the haddock stock is taken by the Scottish demersal whitefish fleet. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland) and VIb (Rockall); it is also a multi-species fishery that lands a number of species other than haddock.

Plaice in IV

Plaice is predominantly caught by beam trawlers in the central part of the North Sea and in a mixed fishery with sole in the southern North Sea. Technical measures applicable to the mixed flatfish beam trawl fishery affect both sole and plaice. The minimum mesh size of 80 mm selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which has a larger minimum landing size than sole. Recent discard estimates indicate fluctuations around 50% discards in catch by weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. The overall capacity and effort of North

Sea beam trawl vessels has been substantially reduced since 1995, including the decommissioning of 25 vessels in 2008.

Saithe in IIIa - IV - VI

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water along the Northern Shelf edge and the Norwegian Trench. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3-4) often are targeted during the rest of the year. In recent years the French fishery has deployed less effort along the Norwegian Trench, while the German and Norwegian fisheries have maintained their effort there. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2-4). In the Norwegian coastal purse seine fishery inside the 4 nm limit (south of 62°N), the minimum landing size is 32 cm. For other gears in the Norwegian zone (south of 62°N) the current minimum landing size is 40 cm, while in the EU zone it is 35 cm. In 2009 the landings were estimated to be around 105 000 t in Sub-area IV and Division IIIa, and 7 000 t in Sub-Area VI, which both are well below the TACs for these areas (125 934 and 13 066 t respectively). Significant discards are observed only in Scottish trawlers. However, as Scottish discarding rates are not considered representative of the majority of the saithe fisheries, these have not been used in the assessment.

Sole in IV

Sole are mainly caught in a mixed beam trawl fishery with plaice and other flatfish using 80 mm mesh in the southern North Sea. The minimum mesh size in the mixed beam trawl fishery in the southern North Sea means that large numbers of under-sized plaice and cod are discarded.

There is a directed fishery for sole by small inshore vessels using trammel nets and trawls, which fish mainly along the English and French coasts and possibly exploit different coastal populations. Sole represents the most important species for these vessels in terms of the annual value to the fishery. The fishery for sole by these boats occurs throughout the year with small peaks in landings in spring and autumn.

In cold winters, sole are particularly vulnerable to the offshore beamers when they aggregate in localized areas of deeper water. Effort from the beam trawl fleet can change considerably depending on whether the fleet moves to other areas or directs effort at other species such as scallops and cuttlefish. In France, there are some few small beam trawlers operating inshore in a few local areas, and offshore trawlers fishing for mixed demersal species taking sole as a bycatch.

The minimum landing size for sole is 24 cm. Demersal gears permitted to catch sole are 80 mm for beam trawling and 90 mm for otter trawlers. Fixed nets are required to use 100 mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

Whiting in IV - VIId

For whiting, there are three distinct areas of major catch: a northern zone, an area off the eastern English coast; and a southern area extending into the English Channel. In the northern area, roundfish are caught in otter trawl and seine fisheries, currently with a 120 mm minimum mesh size. Some vessels operating to the east of this area are using 130 mm mesh. These are mixed demersal fisheries with more specific tar-

geting of individual species in some areas and/or seasons. Cod, haddock and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Minimum mesh size in *Nephrops* trawls is 80 mm but a range of larger mesh sizes are also used when targeting *Nephrops*. Whiting is becoming a more important species for the Scottish fleet, with many vessels actively targeting whiting during a fishing trip and Scottish single seiners have been working closer to shore to target smaller haddock and whiting. The derogation in the EU effort management scheme allowing for extra days fishing by vessels using 90 mm mesh gears with a 120 mm square mesh panel close to the codend (a configuration which releases cod) has so far, been taken up by few vessels. Recent fuel price increases and a lack of quota for deepwater species has resulted in some vessels formerly fishing in deepwater and along the shelf edge to move into the northern North Sea with the shift in fishing grounds likely to result in a change in the species composition of their catches from monkfish to roundfish species including whiting.

Whiting are an important component in the mixed fishery occurring along the English east coast. Industry reports suggest better catch rates here than are implied by the overall North Sea assessment. There has been a displacement of some French vessels steaming from Boulogne-sur-Mer from their traditional grounds in the southern North Sea and English Channel where they have reported very low catch rates during the past two years.

Whiting are a bycatch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through bycatch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small meshed gear is permitted, subject to bycatch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the bycatch limits are likely to be exceeded.

WGFTFB (2008) reported use of bigger meshes in the top panel of beam trawler gear by Belgium vessels with an expected reduction in by-catch of roundfish species, especially haddock and whiting. Fluctuations in fuel costs can cause changes in fishing practices. WGFTFB (2008) reported a shift for Scottish vessels from using 100 mm-110 mm for whitefish on the west coast ground (Area VI) to 80 mm prawn codends in the North Sea (area IV), with increased fuel costs considered the major driver.

Nephrops

Nephrops is caught in a mixed fishery which takes a catch consisting of haddock, whiting, cod, anglerfish and megrim as well as *Nephrops*. Most of the catch (approx 21 of 25 thousand tons) is taken by UK. Days at sea limits apply to *Nephrops* trawlers when using mesh sizes 70-99 mm and in 2009, under the Scottish Conservation Credits Scheme (CCS), the number of days available to Scottish vessels is the same as 2008 and 2007.

A small but increasing proportion of the landings from Subarea IV are taken from statistical rectangles outside the defined *Nephrops* FUs. An example is the Scottish fishery at the Devil's hole which a few boats normally fishing the Fladen grounds prosecute for a few months at the end of the year.

A.3. Ecosystem aspects

These are described in the North Sea ecosystem overview in the ICES advisory report.

B. Data

The mixed fisheries assessment is based on catch and effort data that were compiled mostly on the basis of the data collected by STECF for the evaluation of the effort regime. The data structured by fleets and métiers were used as inputs, together with WGNSSK single-stock data and advice, in the integrated Fcube framework.

The assessment data for the different stocks were taken from ICES (2010). For, plaice, saithe, and sole, no modifications were needed to incorporate the assessment and forecast inputs into the mixed fisheries routine. It should be noted however that no saithe assessment was performed in 2010 due to various data missing, and thus the 2009 assessment was projected over three years instead. The same procedure was followed here. For whiting, the industrial bycatch component was included in the landings, whereas it is dealt with separately in the single-stock forecast. The same applied for haddock, for which the industrial bycatch is now extremely low. The single species haddock forecast also includes some non-standard procedures for projecting mean weight and mean selectivity, and this was accounted for as far as possible in the current mixed-fisheries forecast.

The cod assessment was performed with B-Adapt, which assumed “total removals” consisting of an “overall landings” estimate and a “discards estimates”. The use of the reported landings data from the different fleets was therefore not consistent with the assessment data used by B-Adapt. It was decided to raise the reported landings data from the different fleets to “overall landings” estimates, using the catch multiplier from B-Adapt. This multiplier was applied to all fleets.

For *Nephrops* the data collected at ICES and at STECF level until 2009 were not compatible due to differences in aggregation levels. In order to be able to collate both assessment and fleet related data a specific ICES data call was issued for this stock in 2010. This information covers catches and effort exerted by *Nephrops* functional unit so that stock assessments (analytical for FU's 6-9 and trends based for others) can be incorporated into Fcube.

C. Assessment methodology

Definitions

Two basic concepts are of primary importance when dealing with mixed-fisheries, the Fleet (or fleet segment), and the Métier. Their definition has evolved with time, but the most recent official definitions are those from the CEC's Data Collection Framework (DCF, Reg. (EC) No 949/2008), which we adopt here:

- *A Fleet segment* is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.
- *A Métier* is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area and which are characterized by a similar exploitation pattern.

Model used:

Fcube

The Fcube model is presented and described in Ulrich *et al.* (2006; 2008; 2009). The basis of the model is to estimate the potential future levels of effort by fleet corresponding to the fishing opportunities (TACs by stock and/or effort allocations by fleet) available to that fleet, based on fleet effort distribution and catchability by métier. This level of effort is in return used to estimate landings and catches by fleet and stock, using standard forecasting procedures.

Partial fishing mortality F and catchability q by fleet Fl , métier m and stock St from observed landings LND , effort E and fishing mortality $Fbar$ are estimated for year Y :

$$F(Fl, m, St, Y) = Fbar(St, Y) * \frac{LND(Fl, m, St, Y)}{LNDtot(St, Y)} \quad (1)$$

$$q(Fl, m, St, Y) = F(Fl, m, St, Y) / E(Fl, m, Y) \quad (2)$$

To estimate future parameters value $q(Fl, m, St, Y + 1)$ at year $Y + 1$ an average over recent years can be used. Alternatively, the user may choose to vary the value of q , if evidence exists of e.g. significant technical creep, or of a change in selectivity due to a change in mesh size.

The observed distribution of effort by fleet across métiers is estimated:

$$Effshare(Fl, m, Y) = E(Fl, m, Y) / E(Fl, Y) \quad (3)$$

As with catchability, the simplest approach to the forecast effort distribution $Effshare(Fl, m, Y + 1)$ would be to estimate it from an average of past observed effort allocation. Alternatively, a more complex approach such as a behaviour algorithm could be used if available.

These variables are then used for the forecast estimates of catchability by stock for each fleet. This catchability cannot be directly estimated from observed data, as it is linked to the flexibility of the fleet. While catchability by métier is assumed to be measurable as being linked to the type of fishing, the resulting catchability by fleet varies with the time spent in each métier. The catchability of a fleet is thus equal to the average catchability by métier weighted by the proportion of effort spent in each métier for the fleet:

$$q(Fl, St, Y + 1) = \sum_m q(Fl, m, St, Y + 1) * Effshare(Fl, m, Y + 1) \quad (4)$$

A TAC is usually set in order to achieve a specific fishing mortality. This might be a particular short-term target, such as F_{pa} , or specific reduction in F as part of a longer-term management plan. This intended F is converted into forecast effort by fleet. This step is rather hypothetical, in that it introduces the concept of “Stock dependent fleet effort”. The “stock-dependent fleet effort” is the effort corresponding to a certain partial fishing mortality on a given stock, disregarding all other activities of the fleet. The total intended fishing mortality $F_{target}(St)$ is first divided across fleet segments (partial fishing mortalities) through coefficients of relative fishing mortality by fleet. These coefficients are fixed quota shares estimated from observed landings. In principle, these reflect the rigid sharing rules resulting from the principle of relative sta-

bility, combined with national processes of quota allocation across fleets. The simplest approach is thus to estimate these from observed mean proportions of landings by fleet. The resultant partial fishing mortalities are subsequently used for estimating the stock-dependent fleet effort:

$$F(Fl, St, Y + 1) = Ftarget(St, Y + 1) * QuotaShare(Fl, St) \quad (5)$$

$$E(Fl, St, Y + 1) = F(Fl, St, Y + 1) / q(Fl, St, Y + 1)$$

The final input required is the effort by each fleet during the forecast year. It is unlikely that the effort corresponding to each single-species TAC will be the same across fleets, and it is equally possible that factors other than catching opportunities could influence the amount of effort exerted by a given fleet. Rather than assume a single set of fleet efforts, the approach used in practice with Fcube has been to investigate a number of different scenarios about fleet effort during the forecast period. The user can thus explore the outcomes of a number of options or rules about fleet behaviour (e.g. continue fishing after some quotas are exhausted) or management scenarios (e.g. all fisheries are stopped when the quota of a particular stock is reached).

$$E_{Fl,Y} = rule(E_{Fl,St1,Y}, E_{Fl,St2,Y}, E_{Fl,St3,Y} \dots)$$

For example, if one assumes that fishermen continue fishing until the last quota is exhausted, effort by fleet will be set at the maximum across stock-dependent effort by fleet ("max" option). Overquota catches of species which quota were exhausted before this last one, are assumed to be discarded.

$$E(Fl, Y + 1) = MAX_{st}[E(Fl, St1, Y + 1), E(Fl, St2, Y + 1), \dots] \quad (6)$$

As a contrast, a more conservative option would be to assume that the fleets would stop fishing when the first quota is exhausted, and thus would set their effort at the minimum across stocks ("min" option). Alternatively, management plans for a particular stock could be explored, with the fleets setting their effort at the level for this stock ("stock_name" option). Different rules could also be applied for the various fleets.

The following options are explored:

- 1) **min**: The underlying assumption is that fishing stops when the catch for the first quota species meets the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.
- 2) **max**: The underlying assumption is that fishing stops when the last quota species is fully utilised with respect to the upper limit corresponding to single stock exploitation boundary for agreed management plan or in relation to precautionary limits.
- 3) **cod**: The underlying assumption is that all fleets set their effort at the level corresponding to their cod quota share, regardless of other stocks.
- 4) **sq_E**: The effort is set as equal to the effort in the most recently recorded year for which there is landings and discard data.

- 5) **Ef_Mgt**: The effort in métiers using gear controlled by the EU effort management regime have their effort adjusted according to the regulation (see Council Regulation (EC) No 1342/2008).

All scenarios will be run with two advice approaches, Fmsy transition and management plan. For stocks where a management plan does not exist, the advice according to the latest commission communication on TAC setting is used.

Finally, this resulting effort by fleet is distributed across métiers, and corresponding partial fishing mortality is estimated.

$$E(Fl, m, Y + 1) = E(Fl, Y + 1) * Effshare(Fl, m, Y + 1) \quad (7)$$

$$F(Fl, m, St, Y + 1) = q(Fl, m, St, Y + 1) * E(Fl, m, Y + 1)$$

Partial fishing mortalities are summed by stock, and then used in standard forecast procedures similar to the ones used in the traditional single-species short-term advice. Corresponding landings are estimated and compared with the single-species TAC.

Software used:

The Fcube model has been coded as a method in R (R Development Core Team, 2008), as part of the FLR framework (Kell et al., 2007, www.flr-project.org). Input data are in the form of FLFleets and FLStocks objects from the FLCore 2.2 package, and two forecast methods were used, stf() from the FLAssess (version 1.99-102) and fwd() from the Flash (version 2.0.0) packages. As such, the input parameterisation as well as the stock projections are made externally using existing methods and packages, while only steps 4 to 6 are internalised in the method, thus keeping full transparency and flexibility in the use of the model.

D. Short-Term Projection methodology

Model used: Overview of software used by WGNSSK.

Species	Assessment	Forecast
Haddock IV, IIIa and VIIb	FLR 2x, FLXSA	MFDP
COD IV, IIIa and VIIb	Stochastic B-ADAPT	Stochastic B-ADAPT
PLAICE IV	FLR 3.0, FLXSA	FLR3.0, FLSTF
WHITING IV and VIIId	FLR 2.x, FLXSA	MFDP
SAITHE IV, IIIa and VI	FLR 2.x, FLXSA	FLR 2.x, FLSTF
SOLE IV	FLR 2.x, FLXSA	FLR 2.x, FLSTF
NEPHROPS UWTV	none	none

In the mixed-fisheries runs, all forecasts were done with the same FLR forecasts method (see section C).

For every scenario, the following output is generated per stock:

	Description	Landings	F mult	SSB
Baseline forecast for current year	Applying single species forecast assumptions to last year's data (current year – 1)*	Current yr	Current yr	1st Jan TAC yr
Baseline forecast for TAC year	Applying single species HCRs** to current year results*	TAC yr	TAC yr	1st Jan TAC yr + 1
Current year Fcube results	Applying Fcube to last year's data	Current yr	Current yr	1st Jan TAC yr
Fcube estimate of catches in TAC year	Applying Fcube on current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1
TAC advice results (incl mgt plans)	Applying single species HCRs** to current year Fcube results	TAC yr	TAC yr	1st Jan TAC yr + 1

* For the Baseline runs, a forecast was run for each stock separately following the same settings as in the ICES single species forecast.

** Harvest Control Rules – either from single species management plans or with reference to the F_{MSY} transition approach. Where HCRs according to these approaches were not available values according to the precautionary approach were used.

The following overview table will be produced to be able to judge the relevance of the different scenarios:

		COD HAD PLE POK SOL WHG NEP5 NEP6 NEP7 NEP8 NEP9 NEP10 NEP32 NEP33
Current year	Fbar FmultVsF(current-1) Landings SSB	
Current year + 1	Fbar FmultVsF(current-1) Landings SSB	
Current year + 2	SSB	

G. Biological Reference Points

The biological reference points that are used are the same values as referred to in the single stock advisory reports.

H. Other Issues

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I. References

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Annex 6: Stock-based management plans

Cod in IIIa – IV – VIId (Norway-EU management plan and EU management plan – EC 1342/2008)

EU Norway management plan

In 2008 the EU and Norway renewed their initial agreement from 2004 and agreed to implement a long-term management plan for the cod stock, which is consistent with the precautionary approach and is intended to provide for sustainable fisheries and high yield.

Transitional arrangement:

F will be reduced as follows: 75 % of F in 2008 for the TACs in 2009, 65 % of F in 2008 for the TACs in 2010, and applying successive decrements of 10 % for the following years.

The transitional phase ends as from the first year in which the long-term management arrangement (paragraphs 3

5) leads to a higher TAC than the transitional arrangement.

Long-term management

- 1) If the size of the stock on 1 January of the year prior to the year of application of the TACs is:
 - a) Above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0.4 on appropriate age groups;
 - b) Between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula:

$$0.4 - (0.2 * (\text{Precautionary spawning biomass level} - \text{spawning biomass}) / (\text{Precautionary spawning biomass level} - \text{minimum spawning biomass level}))$$
 - c) At or below the limit spawning biomass level, the TAC shall not exceed a level corresponding to a fishing mortality rate of 0.2 on appropriate age groups.
- 2) Notwithstanding paragraphs 2 and 3, the TAC for 2010 and subsequent years shall not be set at a level that is more than 20 % below or above the TACs established in the previous year.
- 3) Where the stock has been exploited at a fishing mortality rate close to 0.4 during three successive years, the parameters of this plan shall be reviewed on the basis of advice from ICES in order to ensure exploitation at maximum sustainable yield.
- 4) The TAC shall be calculated by deducting the following quantities from the total removals of cod that are advised by ICES as corresponding to the fishing mortality rates consistent with the management plan:

- a) A quantity of fish equivalent to the expected discards of cod from the stock concerned;
 - b) A quantity corresponding to other relevant sources of cod mortality.
- 5) The Parties agree to adopt values for the minimum spawning biomass level (70,000 tonnes), the precautionary biomass level (150,000 tonnes) and to review these quantities as appropriate in the light of ICES advice.
- 6) Procedure for setting TACs in data-poor circumstances
- 7) If, due to a lack of sufficiently precise and representative information, it is not possible to implement the provisions in paragraphs 3 to 6, the TAC will be set according to the following procedure.
- a) If the scientific advice recommends that the catches of cod should be reduced to the lowest possible level the TAC shall be reduced by 25 % with respect to the TAC for the preceding year.
 - b) In all other cases the TAC shall be reduced by 15 % with respect to the TAC for the previous year, unless the scientific advice recommends otherwise.

This plan shall be subject to triennial review, the first of which will take place before 31 December 2011. It enters into force on 1 January 2009.

The main change between this and the plan of 2004 is the phasing (transitional and long-term phase) and the inclusion of an F reduction fraction.

In December 2008 the European Council agreed on a new cod management plan implementing the new system of effort management and a target fishing mortality of 0.4 (EC 1342/2008) for cod stocks in the North Sea, Skagerrak and Eastern Channel as well as in Kattegat, West of Scotland and the Irish Sea. The main rules for setting TAC for the North Sea cod stock are as follows

Article 8: Procedure for setting TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).
2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.
3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75 % for the TACs in 2009, 65 % for the TACs in 2010, and applying successive decrements of 10 % for the following years.
4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:
 - (a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;
 - (b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: $0,4 - (0,2 * \dots)$

- (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))
- (c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.
5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20 % below or above the TACs established in the previous year.
6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.

Haddock in IIIa – IV (EU and Norway management plan)

“The plan consists of the following elements:

1. Every effort shall be made to maintain a minimum level of Spawning Stock Biomass greater than 100,000 tonnes (Blim).
2. For 2009 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140,000 tonnes (Bpa).
3. Where the rule in paragraph 2 would lead to a TAC, which deviates by more than 15 % from the TAC of the preceding year, the Parties shall establish a TAC that is no more than 15 % greater or 15 % less than the TAC of the preceding year.
4. Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to $0.3 - 0.2 * (Bpa - SSB) / (Bpa - Blim)$. This consideration overrides paragraph 3.
5. Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.
6. In the event that ICES advises that changes are required to the precautionary reference points Bpa (140,000t) or Blim, (100,000t) the Parties shall meet to review paragraphs 1-5.
7. In order to reduce discarding and to increase the spawning stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.
8. No later than 31 December 2010, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.
9. This arrangement enters into force on 1 January 2009.”

Saithe in IIIa – IV – VI (EU and Norway management plan)

In 2008 EU and Norway renewed the existing agreement on “a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements.

1. *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass (SSB) greater than 106,000 tonnes (Blim).*
2. *Where the SSB is estimated to be above 200,000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200,000 tonnes but above 106,000 tonnes, the TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to $0.30 - 0.20 \times (200,000 - \text{SSB}) / 94,000$.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106,000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15 % from the TAC of the preceding year the Parties shall fix a TAC that is no more than 15 % greater or 15 % less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15 % compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2012.*
8. *This arrangement enters into force on 1 January 2009."*

Plaice in IV (Multiannual plan for sole and plaice in the North Sea EC 676/2007)

Extract from Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea:

Article 7 Procedure for setting the TAC for plaice:

- 1) *The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:*
 - a) *that TAC the application of which will result in a 10 % reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;*
 - b) *that TAC the application of which will result in the level of fishing mortality rate of 0.3 on ages two to six years in its year of application.*
- 2) *Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which is 15 % greater than the TAC of that year.*
- 3) *Where application of paragraph 1 would result in a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is 15 % less than the TAC of that year.*

Under the consideration nr 3 in the "Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea" it is stated:

The Scientific, Technical and Economic Committee for Fisheries (STECF) has advised that the precautionary biomass for the stock of plaice in the North Sea should be 230 000 tonnes.

Sole in IV (Multiannual plan for sole and plaice in the North Sea EC 676/2007)

Extract from Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea

Article 8 Procedure for setting the TAC for sole:

- 1) *The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:*
 - a) *that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;*
 - b) *that TAC the application of which will result in a 10 % reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.*
- 2) *Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which is 15 % greater than the TAC of that year.*
- 3) *Where the application of paragraph 1 would result in a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is 15 % less than the TAC of that year.*

Under the consideration nr 3 in the “Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea” it is stated:

The Scientific, Technical and Economic Committee for Fisheries (STECF) has advised that the precautionary biomass for the stock of sole in the North Sea should be 35 000 tonnes

Annex 7: Recommendations

Recommendation	For follow up by:
1. ICES should send out a data call to be fulfilled by the end of June 2011 requesting catch (both landings and discards) and effort data for the years 2003-2010.	ICES' secretariat
2. The working group recommends that metier classes be made compatible between the effort, catch and economic datasets requested of nations by STECF as soon as possible.	Commission through STECF
3. ICES WGCHAIRS meeting agree guidelines to achieve consistency in short term forecast methodology between stocks.	ACOM
4. The WGMIXFISH should be extended by one day and meet for five days.	ACOM